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VOL. XLI

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A BELOIT EPISODE IN THE LIFE OF CARL SCHURZ

ROBERT K. RICHARDSON

In the late winter of 1858 the Archaean Society of Beloit College—a student organization lasting well into the twentieth century, though later called the Archaean Union—was casting about for a speaker for its commencement exercises. On Thursday evening, February 4, the last meeting of the presidency of Daniel Densmore, '58, it was voted, on "suggestion" of John H. Edwards of the same class, "that the Chair appoint a committee from the Senior class to procure a public speaker for next commencement." Not unnaturally it was Edwards himself, just previously elected to be Densmore's successor as president, who was appointed chairman of the committee in question. On May 26, soon after the expiry of Mr. Edwards' own term of office, his committee "reported Mr. Carl Schurtz *(sic)* as the orator on that occasion."[1] Mr. Edwards, who was to live until 1919, in an article in the College *Round Table,* January 31, 1908, stated that the selection of Mr. Schurz had been at the instance of "political friends."[2]

Schurz delivered his speech, in the Congregational "Old Stone Church," on Tuesday evening, July 13, 1858. Now forgotten, whereas Lincoln's Hanchett's Hall address is still spoken of, Schurz's oration was perhaps as important a pronouncement as was ever uttered in the city of Beloit. The account of the speech in the *Beloit Journal* of July 15[3] was enthusiastic but, in the nature of the case, could hardly be other than inadequate.

> On Tuesday evening, the Hon. Carl Schurz addressed the Archaean Society at the Congregational Church, which was crowded to its utmost capacity.
>
> The exercises were introduced by prayer from the Rev. Mr. Love, of Milwaukee, after which the Hon. Carl Schurz

---

[1] Records of the Archaean Society, Feb. 4, 1858; May 26, 1858. *Cf.* Sept. 30, 1857 and May 19, 1858. The committee whose names appear in the brochure of the speech as printed consisted of Horatio Pratt and J. H. Edwards, the former being Mr. Edwards' successor in the presidency of the Society.

[2] *Fifty Years Ago.* Pp. 161–164.

[3] P. 2, col. 1. *Cf. The Congregational Herald, Editorial Correspondence,* Thursday, July (22), 1858: "On the evening preceding the commencement, Hon. Carl Schurz, of Watertown, late Republican candidate for the lieutenant governorship, delivered an oration before the Literary Society. His subject was the 'American Idea,' and a most noble discourse he gave, marked by true scholarship, and embodying principles of the soundest wisdom, and morality. Such men as he are a most valuable contribution from the Old World, to our American Society and civilization." The correspondence, from which the above is an excerpt, is signed "E."

delivered one of the most able and eloquent addresses to which we have ever listened. His subject was, "America and Americanism," which he discussed in the broadest and most comprehensive sense. For profound, vigorous thought, sound argument and terse logic, we have seldom heard this effort equalled. For us to attempt anything like a synopsis of this address would be futile. It should have been heard or be read to be appreciated.

Fortunately, as explained by Mr. Edwards in his 1908 article, the political friends who had suggested Schurz to the Society were willing to defray the cost of printing the address. In a brief, polite note of the day following the speech, the Archaean's committee solicited publication, and in his reply of the 24th Mr. Schurz acceded.[4] The phrasing of the consent may be presumed to indicate the way things stood in the writer's mind at the moment.

> . . . The narrow space of a single Address did not permit me to offer you more than a desultory sketch of a multitude of topics, each of which is so comprehensive and so deserving of elaborate exposition. I intended, therefore, to remodel the whole, and to complete my remarks upon several branches of the subject before offering the manuscript for publication. But as your letter and those of other esteemed friends led me to believe that the Address is desired to be published as it was delivered, I send it to you in its original form. If it should succeed in kindling and nourishing in some of its readers a clear consciousness of the great mission of this country, I shall deem myself amply rewarded.

The Beloit speech as printed is a forty-page brochure [B. E. Hale and Company, Beloit, 1858], bearing, both on its cover and first page, the title: *An Address, Delivered Before the Archaean Society of Beloit College, at Its Anniversary, July 13, 1858. By Carl Schurz.* As heading of the Address, on page 5, is the single word *Americanism.*

The importance of the oration thus preserved is that it was the unwitting rehearsal of Schurz's far more important address in Faneuil Hall, of April 18, 1859, entitled *True Americanism.*

The late Superintendent Schafer, in his *Carl Schurz, Militant Liberal,* enumerates six speeches of Schurz between October 16, 1857 and January 4, 1860, inclusive, "whose delivery and publication were largely responsible for the reputation Schurz enjoyed at the opening of the Lincoln campaign."[5] Of these the Boston

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[4] Speech as published, p. 3.

[5] *Carl Schurz, Militant Liberal, Wisconsin Biography Series,* vol. I, 1930, 118, 124, 126. For date October 16, see 107.

speech of April 18 stands fifth in the series. Schafer deems it "probably the most eloquent and impassioned of all his early utterances," and explains that

> It was widely copied by the newspapers, it affected the campaign against anti-foreignism, . . . it opened the way for Schurz as a lecturer in Massachusetts, New Hampshire, New York. In a word it made him a marked man in Yankeedom.

The immediate object of the Faneuil Hall address, as is clear from letters addressed by Schurz to Edward L. Pierce of March 26 and May 12, 1859, was to help deter Massachusetts voters from accepting a Know-Nothing amendment to their state constitution, presented for their approval by the legislature, and providing "that, before gaining the right to vote in Massachusetts, foreign-born persons must not only have become citizens of the United States, which required five years residence in the country, but in addition must have lived in the state two years after becoming citizens." "Wise Republican leaders," continues Dr. Schafer, "deplored that action because to again frighten the foreigners of the country with the bogey of Know-Nothingism would mean the certain defeat of the party in 1860. Some of the young men of Boston, headed by Edward L. Pierce, a friend of Charles Sumner, considering the ways of over-coming the anti-foreign influences, decided to invite Carl Schurz to Boston for an address."[6]

Schurz's own sense of the significance of the legislative proposal in Massachusetts is clearly expounded in his letter to Pierce of March 26, 1859.[7]

> . . . The foreign-born Republicans were drawn to that party by the irresistable force of principle and nothing else. No wing of the party has worked more faithfully and disinterestedly. They did not aspire to position and preferment; but the only thing desired was to see the principles they loved faithfully carried out in practice. The friends of freedom could always count upon them as their truest confederates. They joined the Republican party in spite of the cry of Know-Nothingism, placing their trust in the power of principle over the souls of men and in the good faith of their political friends. Their labors did not remain unrewarded. Republicanism spread among the German population of the Northern States with astonishing rapidity, and even in the

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[6] *Op. cit.*, 123–124. For the letters to Edward L. Pierce of March 26 and May 12, 1859, see *Speeches, Correspondence and Political Papers of Carl Schurz, Selected and Edited by Frederic Bancroft on Behalf of the Carl Schurz Memorial Committee*, vol. I, G. P. Putnam's Sons, 1913, 41 ff.; 75 ff.

[7] *Speeches, Correspondence, etc.*, I, 42–44.

> South the Germans stood everywhere in the vanguard of the movement.
>
> To no class of our population could the action of the Massachusetts legislature be more mortifying than to them. . . . Do not think, sir, that the effect of the action of your legislature will be confined to the limits of your State. . . .
>
> It cannot be expected that the foreign-born Republicans, after this, should place implicit confidence in a party that has given evidence of inconsistency and bad faith, and that they should work with equal enthusiasm as before; and I must confess, although I am no less devoted to the anti-slavery cause than any other man in this country, I can not blame them for it. . . . In most of the States west of the Alleghany Mountains, the Germans hold the balance of power between the parties. The Republican party would never have been able to carry a single one of these States without their co-operation. A change of a few thousand votes in Iowa, Wisconsin, Illinois, Minnesota, Michigan and even Ohio might throw those states into the hands of the pro-slavery party. . . . If the just indignation called forth by the action of your legislature be not allayed by a contrary vote of the people, and if the intention (at present gaining ground among the Germans) to leave the Republican ranks *en masse* and to vote for independent candidates be carried out, the Republicans may lose three or four Western States in 1860, when the change of one may decide the result of the Presidential campaign. And then the State of Massachusetts, that bulwark of anti-slavery principles, would be responsible for the defeat of the anti-slavery cause, and that, too, at a time when, without this, success would have been almost certain.

The Faneuil Hall speech, therefore, not only established Schurz as a national figure, but, despite the subsequent action of the Massachusetts voters in supporting the unfortunate amendment,[8] was significant in strengthening Schurz's hold on the wavering German vote and, we may believe, in guiding the Republican party to that plank in its platform which, in effect, disowned the Know-Nothing behavior of the Bay State.[9]

The Beloit address, unmentioned by Mr. Schafer, came between the first and second speeches of his list, and was, of course, spoken without foresight of Massachusetts conditions.

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[8] Schafer, *op. cit.*, 126. Note Schurz's rueful letter to Pierce of May 12, 1859: "Well, 'the deed is done'; now we have to look out for the consequences. The effect on the Republican party in the Western States will be very serious. . . . You have no idea how the whole thing will embarrass me, unless proper measures are taken to put the responsibility for the measure where it belongs.

"There is in my opinion but one way to set the Republican party right before the people: it is to organize a straight Republican party in Massachusetts, and now is the time to do it." *Speeches, Correspondence, etc.*, I, 75–76.

[9] Schafer, *op. cit.*, 132.

Were this fact not apparent from the dates, it would be amply substantiated by the content of the speech itself and from the note of permission to print sent by Schurz to the Archaean Society. None the less, the speech at Beloit was to furnish the pattern for the Faneuil Hall oration: it was ready to hand when the emergency arose.

The Boston address[10] is much shorter than the Beloit one, about 8,300 words as against about 13,000, and gains immeasurably in unity and force from the compression. The exordia and perorations of the two naturally differ. At Beloit the orator opens, appropriately to an academic occasion, with an explanation of his omission of references to Egypt, Athens and Rome, and states his intention to speak of America "as the great representative of the spirit" of the current age: at Boston, contrariwise, he wins his audience's attention by happy allusions to the State House cupola, to Bunker Hill, to the renowned Tea Party, and to "this grand old hall, which so often resounded with the noblest appeals that ever thrilled American hearts." Despite a fine concluding sentence (still needed in American life)—"Above all, nourish within yourself the sacred fire of that national ambition, which teaches you that to be a true *American* means nothing but to be a true *Man*"—the Beloit peroration, unclearly delimited, is rather commonplace. The Faneuil Hall peroration, though lacking the magnificent phrase just quoted, is as a whole more stirring, though, at the same time, its thought is identical with the end of the speech at Beloit.

> [The inscription on the banner of Western Republicanism from the Alleghany Mountains to the Rockies is] "Liberty and rights, common to all as the air of Heaven—Liberty and equal rights, one and inseparable!"
>
> With this banner we stand before the world. In this sign —in this sign alone, and no other—there is victory. And thus, sir, we mean to realize the great cosmopolitan idea, upon which the existence of the American nation rests. Thus we mean to fulfill the great mission of true Americanism—thus we mean to answer the anxious question of downtrodden humanity—"Has *man* the faculty to be free and to govern himself?" The answer is a triumphant "Aye," thundering into the ears of the despots of the old world that "a man is a man for all that"; proclaiming to the oppressed that they are held in subjection on false pretences; cheering the hearts of the despondent friends of man with consolation and renewed confidence.
>
> This is true Americanism, clasping mankind to its great heart. Under its banner we march; let the world follow.

[10] In *Speeches, Correspondence, etc.*, I, 48–72.

But exordium and peroration aside, the two addresses are essentially identical, always in purport and to a considerable degree in wording. A quarter of the Beloit speech perhaps, not counting material content later deleted in Boston, bears striking verbal resemblance to its great derivative. Parallel columns may furnish lively illustration. Much more might be adduced. Schurz begins by picturing from his very early recollections the departure from his native Rhenish village of a group of emigrants starting for America.

Beloit[11]

It is one of the earliest recollections of my boyhood, that one summer night our whole village was astir in consequence of an uncommon occurrence. I say our village, for I was born in a small hamlet not far from that beautiful spot where the Rhine rolls his green waters out of the wonderful gate of the Seven Mountains and meanders with majestic tranquility through one of the most glorious valleys of the world. That night our neighbors were pressing around a few wagons, covered with linen sheets and loaded with household utensils and boxes and trunks, to their utmost capacity. One of our neighboring families was moving far away across a great water, and it was said that they would never again return. And I saw silent tears trickling down weather-beaten cheeks, and the hands of rough peasants firmly pressing each other, and some of the men and women hardly able to speak when they nodded to one another a last farewell. At last, the train got into motion; they gave three cheers for AMERICA, and then, in the first gray

Boston[12]

It is one of the earliest recollections of my boyhood, that one summer night our whole village was stirred by an uncommon occurrence. I say our village, for I was born not far from that beautiful spot where the Rhine rolls his green waters out of the wonderful gate of the Seven Mountains, and then meanders with majestic tranquillity through one of the most glorious valleys of the world. That night our neighbors were pressing around a few wagons covered with linen sheets and loaded with household utensils and boxes and trunks to their utmost capacity. One of our neighboring families was moving far away across a great water, and it was said that they would never again return. And I saw silent tears trickling down weather-beaten cheeks, and the hands of rough peasants firmly pressing each other, and some of the men and women hardly able to speak when they nodded to one another a last farewell. At last the train started into motion, they gave three cheers for *America,* and then in the first gray dawn of the morning I

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[11] Brochure, 6–7.

[12] *Speeches, Correspondence, etc.,* I, 49–51.

dawn of the morning I saw them wending their way over the hill until they disappeared in the shadow of the forest. And I heard many a man say, how happy he would be if he was able to go with them to that great and free, new country. That was the first time I heard of America, and my childish imagination took possession of a land covered, partly with majestic trees, partly with flowery prairies, immeasurable to the eye, and intersected with large rivers and broad lakes—a land where everybody could do what he thought best, and where nobody was poor because everybody was free. And later, when I was old enough to read, and descriptions of this country, and books on American history fell into my hands, the offspring of my imagination acquired the colors of reality, and I began to exercise my brain with the thought, what man might be and become when left perfectly free to himself. And still later, when ripening into manhood, I looked up from my school books into the stir and bustle of the world, and the trumpet-tones of struggling humanity struck my ear and thrilled my heart, and I saw my nation shake their chains in order to burst them, and I heard a gigantic, universal shout for Liberty rising up to the skies; and, at last, after having struggled manfully and drenched the earth of Fatherland with the blood of thousands of noble beings, I saw that nation crushed down

saw them wending their way over the hill until they disappeared in the shadow of the forest. And I heard many a man say, how happy he would be if he could go with them to that great and free country, where a man could be himself.

That was the first time that I heard of America, and my childish imagination took possession of a land covered partly with majestic trees, partly with flowery prairies, immeasurable to the eye, and intersected with large rivers and broad lakes — a land where everybody could do what he thought best, and where nobody need be poor, because everybody was free.

And later, when I was old enough to read, and descriptions of this country and books on American history fell into my hands, the offspring of my imagination acquired the colors of reality, and I began to exercise my brain with the thought of what man might be and become when left perfectly free to himself. And still later, when ripening into manhood, I looked up from my schoolbooks into the stir and bustle of the world, and the trumpet-tones of struggling humanity struck my ear and thrilled my heart, and I saw my nation shake her chains in order to burst them, and I heard a gigantic, universal shout for Liberty rising up to the skies; and at last, after having struggled manfully and drenched the earth of Fatherland with the blood of thousands of noble beings, I saw that nation crushed down again, not only by overwhelming armies, but by the dead weight of customs and institutions, and notions, and prejudices, which past centuries had heaped upon her shoulders, and which a moment of enthusiasm, however sublime, could not destroy — then I consoled an almost despondent heart with the idea of a youthful people, and of original institutions, clearing the way for an untrammeled development of the ideal nature of man. Then I turned my eyes instinctively across the Atlantic Ocean, and America, and Americanism, as I fancied it, became to me the last depository of the hopes of all true friends of Humanity.

I say all this, not as though I indulged in the presumptuous delusion, that my personal feelings and experience could be of any interest to you, but in order to show you what America is to the thousands of thinking men in the old world, who, disappointed in their fondest hopes, and depressed by the saddest experience, cling with their last remnant of confidence in human nature to the last spot on earth, where man is free to follow the road to attainable perfection, and where, unbiased by the disastrous influence of traditional notions, customs and institutions, he acts on his own responsibility.

again, not only by overwhelming armies, but by the dead weight of customs and institutions and notions and prejudices which past centuries had heaped upon them, and which a moment of enthusiasm, however sublime, could not destroy; then I consoled an almost despondent heart with the idea of a youthful people and of original institutions clearing the way for an untrammeled development of the ideal nature of man. Then I turned my eyes instinctively across the Atlantic Ocean, and America and Americanism, as I fancied them, appeared to me as the last depositories of the hopes of all true friends of humanity.

I say all this, not as though I indulged in the presumptuous delusion that my personal feelings and experience would be of any interest to you, but in order to show you what America is to the thousands of thinking men in the old world, who, disappointed in their fondest hopes and depressed by the saddest experience, cling with their last remnant of confidence in human nature, to the last spot on earth where man is free to follow the road to attainable perfection, and where, unbiased by the disastrous influence of traditional notions, customs and institutions, he acts on his own responsibility.

When Rev. Dr. Edwards wrote in 1908 that the Beloit address was really "the stepping-stone to [Schurz's] public career" he was obviously forgetting a large block of Wisconsin history: but when he stated that the speech was "repeated soon after in Boston," he hit close to the truth. The saying, attributed to

Oliver Cromwell, that "No one goes so far as the man who doesn't know where he is going,"[13] was holding true of Carl Schurz on that July Tuesday evening of 1858: Beloit was on Schurz's road to Boston and Boston was to be the portal of Schurz's national reputation and, perhaps, of Lincoln's election. An important speech, that Beloit address!

Not until September 29, 1858, did the Treasurer's Book of the Archaean Society of Beloit College exhibit the entry: "Sept 29 To Carl Schurz for lecture. 15.00."[14] We trust that the boys had explained to their speaker, back in July, that he must await his pay over the long vacation. Yet in reality his peculium was national repute and a striking part in the preservation of the Union and the overthrow of American slavery.[15]

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[13] A. V. Dicey, *Lectures on the Relation Between Law and Public Opinion in England,* 2nd ed., 1920 reprint, London, 1920, ft. 231.

[14] Treasurer's Book of the Archaean Society of Beloit College. Money for the payment for publication of Mr. Schurz's speech seems not to have passed through the Treasurer's hands: at least there is no such item in the accounts.

Dr. Edwards notes that in conversation years later, Schurz told him that he remembered the Beloit affair "well and pleasantly." Schurz does not mention it in his *Reminiscences* and apparently set little store by it.

[15] For notice of Schurz's participation with others in a huge Republican rally at Beloit, July 13, 1860, with delegates present from Janesville, Rockford, Freeport, and Green and Walworth counties, at which, with others, Schurz spoke afternoon and evening, see *Beloit Journal and Courier* (weekly), July 19, 1860, p. 2, cols. 1 and 2.

It is well known that Carl Schurz acquired his remarkable facility in English, in part, by constantly noting down and absorbing into his own instinctive speech what he considered notable phrases or idioms, wherever found. The peroration of the Boston address furnishes what look like two examples.

1. "Liberty and equal rights, one and inseparable." *Cf.* the close of Webster's Reply to Hayne: "Liberty *and* Union, now and forever, one and inseparable!"

2. " 'A man is a man for all that.' " From Burns.

"In this sign—in this sign alone, and no other—there is victory" comes doubtless straight from the Latin *In hoc signo vinces.*

LOCATIONS OF DRUMLINS IN THE TOWN OF LIBERTY GROVE, DOOR COUNTY, WISCONSIN

O. L. KOWALKE

The drumlins in the Town of Liberty Grove attracted the author's interest when he made the survey of the Highest Abandoned Beach Ridges in Northern Door County. (*Trans. Wis. Acad. of Sc. Arts & Letters,* Vol. 38, p. 293.) Door County is in eastern Wisconsin and embraces most of the peninsula that lies between the waters of Green Bay and of Lake Michigan. The Town of Liberty Grove, a political unit, lies at the north end of the Door County peninsula; it extends about 12 miles from south to north; its average width, east to west, between Lake Michigan and Green Bay is about 5.2 miles; and it is located within survey Towns 31, 32, and 33 North of the Wisconsin–Illinois boundary and Ranges 28 and 29 East of the 4th Principal Meridian.

The land facing Green Bay, in general, rises abruptly from the shore line and in several places it rises vertically for over 100 feet. That fact is shown on the accompanying map by the contour line for 650 feet above sea level, the waters of Green Bay and Lake Michigan being at 578 feet. Note also along State Highway 42 the regions in Range 28 East whose elevations are, respectively, 755 feet on the west line of Sec. 7, T31N; 730 feet at the S.W. corner of Sec. 28, T32N; 736 feet in Sec. 15 and 16, T32N; and a high of 800 feet in Sec. 22, T32N. From those high areas the land slopes fairly gradually toward the south-east to Lake Michigan.

Practically all the land on which the drumlins are located is now or has been cultivated; all the original forest cover is gone. The drumlins, on that account, have undoubtedly been eroded away considerably.

As shown on the map, the drumlins lie in two groups. One group lies south of the village of Ellison Bay and northeasterly from Sister Bay; and the other lies south of the village of Sister Bay.

Those drumlins lying south of Ellison Bay and north-easterly from Sister Bay may also be divided. Those lying in Secs. 26, 27, and 28 constitute one group and those lying in Secs. 33, 34, and 35 constitute the other group, both groups being in T32N, R28E.

The group in Secs. 26, 27, and 28 lies in fields that have been cultivated from time to time. These drumlins are low, none being over 10 feet high above the surrounding surfaces, and the slopes to the crests are not steep.

The group in Secs. 33, 34, and 35 also lies in cultivated fields and some units are in cherry orchards. The drumlins in this group are, in general, much higher than those of the preceding group. The elevations of three of the drumlins are noted on the map as 732 feet, 736 feet, and 740 feet, respectively, above sea level. The elevation at a highway intersection at the center of Sec. 35 is 690 feet. Thus the three drumlins have crests 40 to 50 feet above the surrounding ground.

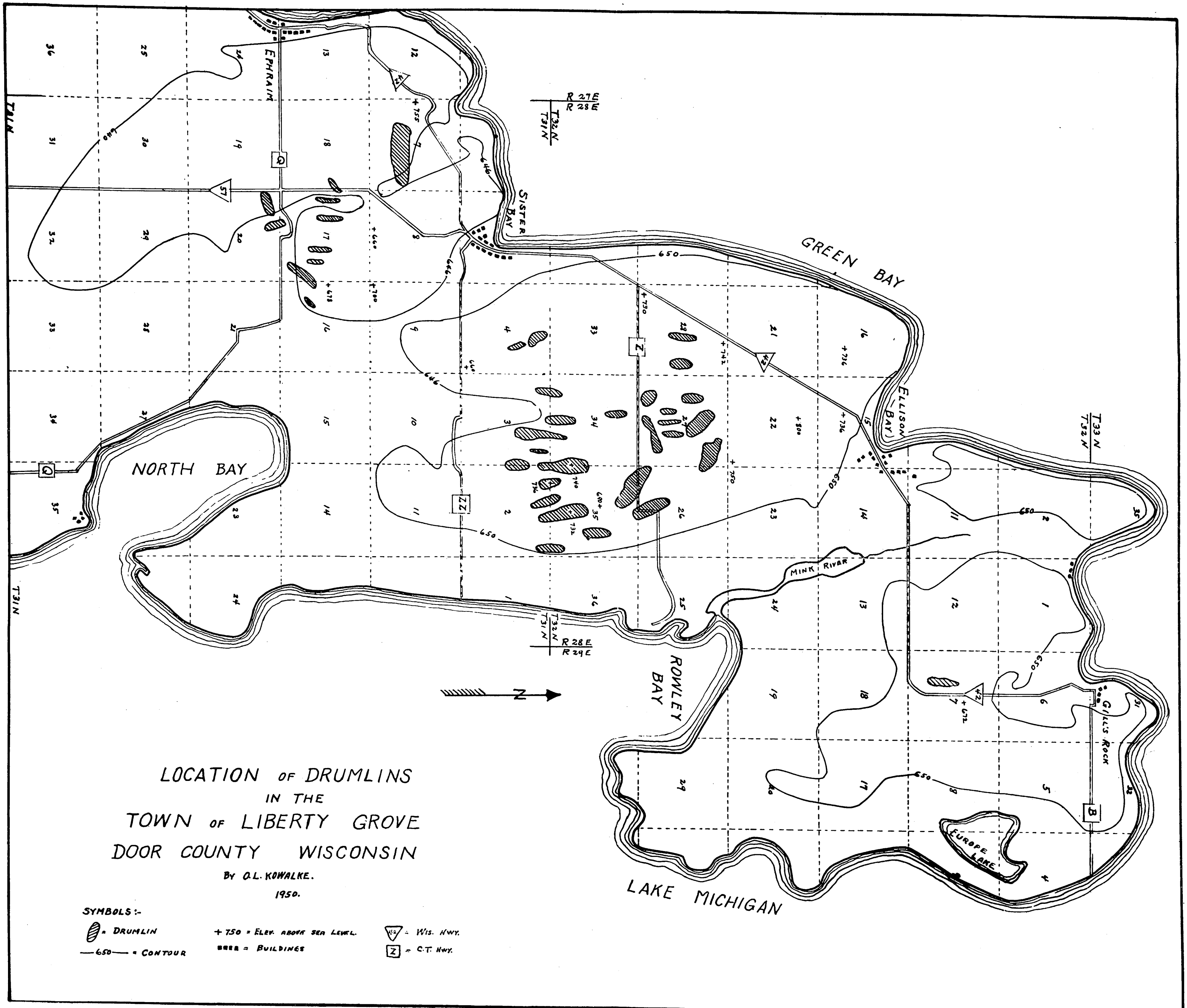
The soil in Sections 26 and 27 is classified as Miami gravelly loam. (*Wis. Geol. & Nat. Hist. Sur. Bul. No. 52-D,* Soil Series No. 10.) It appears then that the drumlins in this area have been eroded considerably and that perhaps they are older than those in Sections 34 and 35. The soil in Sections 34 and 35 is classified as Miami fine sandy loam and it may have been washed from the higher ground in Sections 26 and 27.

That group of drumlins lying south of Sister Bay in Sections 7, 16, 17, and 20 differs from the preceding groups in that the individual drumlins are, in general, smaller and they are not over 10 feet high. Most of them are covered with a second-growth forest.

The drumlin lying in the northwest corner of Section 20, near the intersection of Highways 57 and Q, is conspicuous because on its crest now stand a church with its parsonage and a private dwelling. Furthermore, a part of the drumlin was cut away when Highway 57 was graded.

It is debatable whether the low ridge shown as a drumlin in Section 7 should be called a drumlin, because it is so near the contour of 646 feet, the level of post-glacial Lake Algonquin. On the other hand, the soil in it is a mixture of sand, loam, gravel and boulders.

Drumlins may have been deposited elsewhere in the Town of Liberty Grove, but if they were in regions outside the contour of 650 feet, they would have been destroyed and washed away by waves in the post-glacial Lake Algonquin.


LOCATION OF DRUMLINS
IN THE
TOWN OF LIBERTY GROVE
DOOR COUNTY WISCONSIN
BY O.L. KOWALKE.
1950.
SYMBOLS:-
= DRUMLIN
—650— = CONTOUR
+ 750 = ELEV. ABOVE SEA LEVEL.
= BUILDINGS
= WIS. HWY.
Z = C.T. HWY.
GREEN BAY
LAKE MICHIGAN
NORTH BAY
ROWLEY BAY
SISTER BAY
ELLISON BAY
EPHRAIM
GILL'S ROCK
MINK RIVER
EUROPE LAKE
T33N
T32N
T31N
R27E
R28E
R29E
N

PARASITES OF NORTHWEST WISCONSIN FISHES
III. THE 1946 SURVEY[1]

JACOB H. FISCHTHAL[2]

ABSTRACT

In a survey of fish parasites during 1946 from 47 lakes and streams in northwest Wisconsin, 1,547 fishes representing 46 different species and subspecies were examined and 1,394 or 90.1 per cent were infected with at least one species of parasite. The number of fish infected with each parasite from each water as well as the intensity of infection is presented in tabular form for each species of fish examined. A check list of parasites and the number of different species of fishes infected with each is also given. The larval parasites occurred most frequently and in more species of fishes than did the other developmental stage. The yellow grub, *Clinostomum marginatum,* was found in 10 species of fishes; the black spot parasites, *Neascus* spp., in 30 species; the gill flukes (Gyrodactyloidea) in 19 species; and the bass tapeworm, *Proteocephalus ambloplitis,* in 11 species.

INTRODUCTION

The present paper covering the year 1946 is the third and final in a series of annual reports on a parasite survey of northwest Wisconsin fishes, and is in continuation of the desire for more knowledge of the distribution, incidence and intensity of parasitism in fishes from the many lakes and streams of Wisconsin as originally set forth. The first two reports in this series by Fischthal (1947 and 1950) record the parasite survey data for 1944 and 1945 respectively. Part IV (Summary and Limnological Relationships) will conclude this study and will appear at a later date.

The 1946 survey was started February 19 and was terminated December 9. During this period fishes were examined from 47 different lakes and streams as shown in Table 1. These fishes were collected for the most part by the use of fyke nets in lakes and an electric shocking device in streams. Other means used for collecting fishes were a gill net, a common-sense minnow seine

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[1] Contribution from the Fish Management Division, Wisconsin Conservation Department.

[2] Department of Biological Sciences, Harpur College, State University of New York, Endicott, New York.

and a dip net. Some of the fishes were examined fresh within a few days after capture; however, the majority were frozen and stored in a frozen-food locker until needed.

A total of 1,547 fishes, representing 46 different species and subspecies, were examined for parasites and 1,394 or 90.1 per cent were infected with at least one species of parasite (data summarized in Table 2). Three hundred and seventeen or 20.9 per cent of the 1,547 fishes examined were from streams and 249 or 78.5 per cent of these 317 fishes were parasitized. The remaining 1,230 or 79.1 per cent of the 1,547 fishes examined were from lakes and flowages and 1,145 or 93.1 per cent of these 1,230 fishes were infected. Bangham (1946) in a survey of northern Wisconsin fishes during 1943, covering mainly the northeastern section of the state, found 93.2 per cent of 1,330 fishes infected with parasites. Approximately 8.7 per cent of these 1,330 fishes examined were from streams. The fishes from streams showed an 80.2 per cent infection, while the remainder from lakes and flowages were 94.4 per cent infected. Fischthal (1947) encountered parasites in 96.4 per cent of 2,059 fishes surveyed from northwest Wisconsin during 1944. Of these 2,059 fishes examined, 32.5 per cent were from streams. The fishes from streams were 92.7 per cent parasitized, while the remainder from lakes and flowages were 98.2 per cent infected. Fischthal (1950) recovered parasites from 87.2 per cent of 926 fishes from northwest Wisconsin during 1945. Approximately 60.5 per cent of the 926 fishes examined were from streams. The fishes from streams were 80.1 per cent infected, while the remainder from lakes and flowages were 98.1 per cent infected.

If the figures for the 1944 and 1945 surveys, respectively, by Fischthal (1947, 1950) are combined with those in this report for 1946, all three surveys covering northwest Wisconsin, it is seen that 4,532 fishes were examined over a three-year period and that 4,186 or 92.4 per cent were infected. Of these 4,532 fishes examined, 34.4 per cent were from streams. The fishes from streams were 85.3 per cent parasitized, while the remainder from lakes and flowages were 96.1 per cent infected. The 92.4 per cent total infection for the three years of surveys is relatively high in comparison with surveys conducted elsewhere. Freshwater fishes from southern Florida studied by Bangham (1940) showed 88 per cent of 1,380 fishes parasitized. Bangham (1941) found 84.3 per cent of 560 fishes from Algonquin Park (Ontario) lakes infected. In a further study of the Algonquin Park region Bangham and Venard (1946) showed 75.8 per cent of 676 fishes to harbor at least one species of parasite. Hunter (1941) found parasites in 72.5 per cent of 598 Connecticut fishes

TABLE 1

Lakes and Streams Surveyed for Parasites

Lake or Stream	County	Location	Water Condition	1946 Collection Date
Ashegon Lake	Sawyer	Town 39 North, Range 8 West, Section 24	Very soft, clear	6/29
Beaver Dam Lake	Barron	T35N, R13W, S5 T36N, R14W, S35	Medium, clear	4/19
Big Falls Flowage	Rusk	T36N, R5W, S26, 35	Medium, brown	8/9
Chenaqua Lake (Lake 5)	Bayfield	T43N, R5W, S34	Very soft, clear	8/9
Chippewa Flowage	Sawyer	T40N, R7W, S23, 25, 26	Medium, brown	4/29
Chippewa River	Sawyer	T39N, R6W, S2	Medium, brown	10/8
Clear Lake	Burnett	T38N, R16W, S19, 20	Very soft, clear	7/10
Dells Pond	Eau Claire	T26N, R6W, S19, 20	Medium soft, brown	7/19
Devils Creek	Rusk	T35N, R8W, S17 T35N, R9W, S22	....	6/7, 9/21
Duncan Creek	Chippewa	T31N, R9W, S17, 20	....	12/9
East Twin Lake	Bayfield	T49N, R6W, S36	Very soft	7/12
Ellison Lake	Bayfield	T45N, R9W, S19, 30	Medium, clear	7/10
Fairchild Pond	Eau Claire	T25N, R5W, S35	Soft, brown	7/14
Granite Lake	Barron	T36N, R13W, S20, 29	Medium	7/21
Half Moon Lake	Eau Claire	T27N, R9W, S19	Medium soft	7/23
Hay Creek Pond	Clark	T26N, R4W, S15	Very soft, brown	7/16
Horse Lake	Polk	T33N, R18W, S26	Hard, brown	2/19
Knuteson Creek	Sawyer	T37N, R9W, S2	....	10/2
Ladysmith Flowage	Rusk	T35N, R6W, S34	Medium, brown	8/6
Little Bear Creek	Barron	T36N, R12W, S22, 25, 26	....	10/14
Little Clam Lake	Ashland	T42N, R4W, S5	Very soft, clear	8/3
Little Granite Lake	Barron	T36N, R13W, S29	Medium soft, clear	7/24
Little Long Lake (Poquette)	Burnett	T38N, R14W, S2, 3	Medium, clear	6/25
Little Star Lake	Bayfield	T45N, R7W, S11	Brown	7/20
Long Lake (Bellevue) (1)	Bayfield	T46N, R7W, S29	Medium, light brown	7/19

TABLE 1—*(Continued)*

LAKES AND STREAMS SURVEYED FOR PARASITES

LAKE OR STREAM	COUNTY	LOCATION	WATER CONDITION	1946 COLLECTION DATE
Long Lake (2)	Bayfield	T48N, R5W, S6	Very soft, clear	7/12
		T48N, R6W, S1		
Long Lake (W)	Washburn	T37N, R11W, S22, 23	Hard, clear	5/6
Lower Clam Lake	Sawyer	T42N, R5W, S11, 12	Medium soft, brown	7/27
Lower Pine Lake	Polk	T32N, R18W, S23	Soft, clear	9/24
McCann Creek	Chippewa	T30N, R8W, S7	....	12/9
McKenzie Creek	Polk	T37N, R16W, S36	....	6/5
Mondeaux Flowage	Taylor	T33N, R1W, S24, 25	Medium soft, brown	8/1
Moose Lake	Sawyer	T41N, R5W, S17	Medium, brown	5/10
		T41N, R6W, S13, 25		
Mud Hen Lake	Burnett	T38N, R17W, S16, 17	Hard, clear	7/27
Osceola Creek	Polk	T33N, R19W, S25	....	2/19
Pelican Lake	Sawyer	T39N, R3W, S25	Very soft, clear	7/25
St. Croix Lake	Douglas	T45N, R11W, S18, 19	Medium soft, clear	6/28
		T45N, R12W, S25, 36		
Sauntry's Pocket	Douglas	T43N, R11W, S1	Medium soft, clear	2/28
Simms Lake	Douglas	T44N, R10W, S30	Soft, clear	7/3
		T44N, R11W, S25		
Siskowitt Lake	Bayfield	T50N, R6W, S20, 21	Very soft, brown	7/16
Somers Creek	Polk	T37N, R16W, S27	....	6/5
Spring Lake	Sawyer	T41N, R7W, S14	....	5/24
Lake Superior	Douglas	T49N, R10W, S10	....	4/16, 5/6
Upper Clam Lake	Ashland	T42N, R4W, S6	Medium, brown	7/31
		T43N, R4W, S31		
Wapogasset Creek	Polk	T35N, R17W, S26	....	2/19
West Twin Lake	Bayfield	T49N, R6W, S36	Very soft	7/12
White Bass Lake (Muskie)	Bayfield	T43N, R5W, S25	Medium, clear	8/7

TABLE 2

SUMMARY OF PARASITE SURVEY DATA

FISH	NO. EXAM.	NO. INF.	% INF.	NO. WATERS EXAM.	NO. SPP. PARASITES FOUND
1. *Acipenser fulvescens*	1	1	100	1	4
2. *Amia calva*	8	8	100	3	9
3. *Osmerus mordax*	13	13	100	1	5
4. *Leucichthys artedi*	2	2	100	1	1
5. *Salmo gairdnerii irideus*	7	5	71	2	2
6. *Salmo trutta fario*	17	7	41	3	2
7. *Salvelinus f. fontinalis*	38	31	82	3	6
8. *Catostomus c. commersonnii*	89	76	85	23	15
9. *Catostomus c. catostomus*	5	5	100	1	2
10. *Moxostoma rubreques*	14	14	100	6	13
11. *Semotilus a. atromaculatus*	37	34	92	8	9
12. *Rhinichthys atratulus meleagris*	16	14	88	3	4
13. *Rhinichthys c. cataractae*	14	10	71	6	5
14. *Notemigonus crysoleucas auratus*	22	18	82	5	6
15. *Notropis cornutus frontalis*	13	13	100	3	9
16. *Notropis hudsonius selene*	2	2	100	1	3
17. *Notropis heterodon*	21	14	67	3	4
18. *Notropis h. heterolepis*	21	18	86	3	5
19. *Pimephales p. promelas*	2	2	100	1	1
20. *Hyborhynchus notatus*	13	13	100	2	3
21. *Campostoma anomalum pullum*	1	0	0	1	0
22. *Ameiurus m. melas*	1	1	100	1	1
23. *Ameiurus n. nebulosus*	44	32	73	12	21
24. *Ameiurus n. natalis*	22	22	100	3	11
25. *Pilodictis olivaris*	6	6	100	2	4
26. *Umbra limi*	8	5	63	5	5
27. *Esox lucius*	40	40	100	9	11
28. *Esox m. masquinongy*	7	7	100	5	13
29. *Fundulus diaphanus menona*	4	4	100	1	5
30. *Percopsis omiscomaycus*	2	2	100	1	5
31. *Perca flavescens*	122	114	93	20	25
32. *Stizostedion v. vitreum*	85	85	100	15	25
33. *Boleosoma nigrum eulepis*	3	3	100	1	5
34. *Boleosoma n. nigrum* x *B. n. eulepis*	33	26	79	6	9
35. *Poecilichthys exilis*	23	22	96	2	9
36. *Poecilichthys flabellarisl ineolatus*	20	12	60	3	3
37. *Micropterus d. dolomieu*	19	19	100	5	16
38. *Micropterus salmoides*	77	75	97	18	26
39. *Lepomis cyanellus*	4	4	100	2	5
40. *Lepomis gibbosus*	110	108	98	20	25
41. *Lepomis m. macrochirus*	220	206	94	26	24
42. *Ambloplites r. rupestris*	72	70	97	13	24
43. *Pomoxis nigro-maculatus*	229	205	90	25	16
44. *Cottus b. bairdii*	12	11	92	2	3
45. *Eucalia inconstans*	21	8	38	4	6
46. *Pungitius pungitius*	7	7	100	1	7
TOTALS	1,547	1,394	90.1		

examined. In a survey of Lake Erie, Bangham and Hunter (1939) found 58.3 per cent of 2,156 fishes infected with parasites. Essex and Hunter (1926) obtained parasites from 39 per cent of 652 fishes from lakes and streams of the central states.

In Table 1, the locations given for streams are those points at which collections were made. In collecting from lakes, fyke nets were set in varying aquatic environments in order to obtain as representative a sample of fishes as possible and under varied ecological conditions. In Tables 3–22 no mark preceding the names of the parasites indicates an adult stage; an inverted T (⊥) before the parasite denotes the presence of both adult and immature stages in the same fish; two asterisks (**) preceding the parasite indicates an immature stage; a single asterisk (*) preceding the parasite indicates a larval stage; the superimposed number one (^{1}) following the number of infected fish or a light infection in the text data indicates an infection with 1–10 specimens of that species; the superimposed number two (^{2}) or a moderate infection denotes an infection with 11–50 specimens; the superimposed number three (^{3}) or a heavy infection indicates an infection with 51 or more specimens. The use of sp. or spp. after a generic name or a broader classification than genus indicates that the specimens could not be identified more completely. The notations (1) and (2) following Long Lake are used to designate that two different Long lakes in Bayfield county are being considered; the notation (W) after a third Long lake, located in Washburn county, is used to differentiate this lake from the two Long lakes in Bayfield county.

Appreciation is due the Fishery Biology and Fish Propagation personnel at Spooner, Wisconsin, for their aid in collecting the fishes used in this survey. Thanks are also due Dr. H. J. Van Cleave, University of Illinois, for identification of *Neoechinorhynchus saginatus* and *rutili* in the hosts recorded herein.

Acipenser fulvescens Raf., Rock sturgeon: One fish was examined from the Ladysmith Flowage. It was lightly infected with *Allocreadium* sp., *Cucullanus* sp., *Spinitectus carolini,* and moderately with immature *Crepidostomum lintoni.*

Osmerus mordax (Mitchill), American smelt: All 13 smelt from Lake Superior were infected. Five were lightly parasitized with larval *Diplostomulum* sp. in the lens of the eye, and one with *Neoechinorhynchus* sp. Immature *Bothriocephalus* sp. occurred lightly in 4, moderately in 1; *Cystidicola stigmatura* lightly in 9, moderately in 4; *Leptorhynchoides thecatus* lightly in 6, moderately in 1.

Leucichthys artedi (LeSueur), Cisco or lake herring: Two from Lower Pine lake were moderately infected with immature *Proteocephalus* sp.

Salmo gairdnerii irideus Gibbons, Coast rainbow trout: Five (71 per cent) of 7 fish from 2 streams harbored parasites. Larval glochidia occurred lightly in the 1 McKenzie creek trout, and immature *Allocreadium lobatum* was lightly present in 4 of the 6 Osceola creek fish.

Salmo trutta fario Linn., Brown trout: Seven (41 per cent) of 17 fish were parasitized. The 2 Osceola creek fish were negative. The 4 Hay creek pond fish were all lightly infected with *Spinitectus carolini*. Only 3 of the 11 McKenzie creek trout were lightly infected with immature *Allocreadium lobatum*.

Salvelinus f. fontinalis (Mitchill), Common brook trout: Thirty one (82 per cent) of the 38 fish from 3 waters were parasitized. Only 12 of the 13 fish from Devils creek were infected, 2 lightly with *Neoechinorhynchus rutili* and 1 with *Rhabdochona cascadilla;* 10 were lightly infected, 1 moderately, and 1 heavily with *Crepidostomum farionis*. All 12 Duncan creek trout harbored parasites, 1 light infection with *Abothrium crassum,* 2 with *N. rutili,* and 1 with *R. cascadilla;* 6 lightly and 1 moderately with larval *Neascus* sp., Seven of 13 Little Star lake fish were lightly infected with larval *Spiroxys* sp.

Catostomus c. catostomus (Forster), Eastern sturgeon sucker: The 5 Lake Superior fish were lightly parasitized, 3 with larval *Diplostomulum* sp. in the lens of the eye, 4 with *Neoechinorhynchus crassus,* and 1 with larval *Neoechinorhynchus* sp. encysted in the mesentery.

Bowfin (Table 3)

All 8 bowfin were parasitized. The larval *Diplostomulum* sp. were recovered from the lens of the eye of a Mud Hen lake fish.

Common white sucker (Table 4)

Seventy-six (85.4 per cent) of the 89 suckers were infected. The Chippewa river and Knuteson creek suckers were fingerlings. The larval *Diplostomulum* sp. occurred in the lens of the eye. The larval *Triaenophorus nodulosus* were encysted in the liver and less frequently in the mesentery. The Myxospordia occurred in cysts on the gills.

Greater redhorse (Table 5)

All 14 greater redhorse were parasitized. The larval *Diplostomulum* sp. occurred in the lens of the eye. The larval *Triaeno-*

phorus nodulosus was observed in the liver and mesentery. The *Myxosporidia* were seen in cysts on the gills.

Northern creek chub (Table 6)

Thirty-four (91.9 per cent) of the 37 creek chubs were parasitized. The larval *Diplostomulum* sp. was observed in the lens of the eye. The immature *Contracaecum* sp. occurred in the intestine.

Rhinichthys atratulus meleagris Agassiz, Western blacknose dace: Fourteen (88 per cent) of the 16 dace were infected. One of three Osceola creek fish had a light infection with a larval Trematoda encysted in the mesenteries. The 1 McCann creek fish was lightly parasitized with larval *Posthodiplostomum minimum* and *Rhabdochona cascadilla,* and heavily with larval *Neascus* sp. All 12 Duncan creek fish harbored parasites; 4 lightly with larval *P. minimum* and 1 with *R. cascadilla,* and 2 lightly, 7 moderately and 3 heavily with larval *Neascus* sp.

Rhinichthys c. cataractae (Valenciennes), Great Lakes longnose dace: Ten (71 per cent) of 14 dace harbored parasites. The 1 McKenzie creek fish was negative. Four of the 6 Chippewa river fish were lightly infected with immature *Camallanus oxycephalus.* The 1 Devils creek fish had 9 Myxosporidia cysts in the intestinal wall. The 2 Duncan creek dace were infected, 1 lightly with larval *Posthodiplostomum minimum* and the other with *Rhabdochona cascadilla;* one of these was lightly infected with larval *Neascus* sp., the other moderately. Only 1 of the 2 Osceola creek fish harbored light infections with Myxosporidia in 2 cysts on the fins, and larval *P. minimum. R. cascadilla* occurred lightly in the 2 Somers creek fish.

Western golden shiner (Table 7)
Northern common shiner (Table 8)

All 13 common shiners were parasitized. The larval *Diplostomulum* sp. occurred in the lens of the eye. The Myxosporidia were in two cysts in the flesh.

Notropis hudsonius selene (Jordan), Northern spottail shiner: The 2 Lake Superior fish harbored light infections with larval *Diplostomulum* sp. in the lens of the eye and larval *Neascus* sp., while only 1 had larval *Posthodiplostomum minimum.*

Notropis heterodon (Cope), Blackchin shiner: Fourteen (67 per cent) of the 21 fish were infected. The 3 from Osceola creek were negative. The 2 Wapogasset creek shiners were parasitized, 1 lightly with larval *Diplostomulum* sp. in the lens of the eye, the other moderately. Only 12 of the 16 fish from Sauntry's

Pocket were parasitized, 7 lightly with immature *Contracaecum* sp. in the liver, and 5 with larval *Posthodiplostomum minimum;* Myxosporidia, occurring in cysts in the mesenteries, were lightly present in 5, moderately in 1.

Notropis h. heterolepis Eig. and Eig., Northern blacknose shiner: Eighteen (86 per cent) of the 21 fish were parasitized. The 3 Horse lake fish were negative. The 3 Wapogasset creek shiners were lightly infected with larval *Diplostomulum* sp. in the lens of the eye. All 15 Sauntry's Pocket fish were infected, 7 lightly with immature *Contracaecum* sp. in the liver, 10 with Gyrodactyloidea, and 9 with larval *Posthodiplostomum minimum;* 3 lightly and 2 moderately with *Trichodina* sp. on the gills.

Pimephales p. promelas Raf., Northern fathead minnow: The 2 Long lake (2) fish were lightly infected with larval *Neascus* sp.

Hyborhynchus notatus (Raf.), Bluntnose minnow: All 13 fish from 2 waters were infected. The 3 Osceola creek minnows bore light infections of larval *Posthodiplostomum minimum.* The 10 Wapogasset creek fish were all infected, 1 lightly with larval *Neascus* sp. and 2 with larval *P. minimum;* 9 were lightly and 1 moderately parasitized with larval *Diplostomulum* sp. in the lens of the eye.

Campostoma anomalum pullum (Agassiz), Central stoneroller: One fish examined from the Chippewa river was parasite free.

Ameiurus m. melas (Raf.), Northern black bullhead: The 1 Chippewa Flowage fish was lightly infected with Gyrodactyloidea.

Northern brown bullhead (Table 9)

Thirty-two (72.7 per cent) of the 44 brown bullheads were infected. The Knuteson creek fish was a fingerling. The immature *Contracaecum* sp. occurred in the intestine, while the larval stage was observed in the mesenteries. The larval *Diplostomulum* sp. was recovered from the lens of the eye. The larval *Pomphorhynchus bulbocolli, Proteocephalus* sp., and *Spiroxys* sp. were taken from the mesenteries.

Northern yellow bullhead (Table 10)

All 22 yellow bullheads harbored at least one species of parasite. The immature *Contracaecum* sp. was recovered from the intestine. The larval *Diplostomulum* sp. occurred in the lens of the eye. The Myxosporidia were observed in cysts on the gills.

Pilodictis olivaris (Raf.), Shovelhead catfish: All 6 from 2 waters were infected. Of the 2 Big Falls Flowage fish, 1 was lightly parasitized with *Alloglossidium corti,* and 1 moderately with immature and adult *Corallobothrium giganteum.* Of the 4

Ladysmith Flowage fish, 1 was lightly infected with *Camallanus oxycephalus,* and 1 with *Crepidostomum cornutum;* both immature and adult *C. giganteum* occurred lightly in 2, moderately in 1, while immature only occurred lightly in 1.

Umbra limi (Kirtland), Western mudminnow: Five (63 per cent) of the 8 fish from 5 waters were infected. *Phyllodistomum brevicecum* occurred lightly in the 1 Devils creek fish. Only 1 of the 3 Duncan creek fish harbored *Bunoderina eucaliae* lightly. One of the 2 Little Bear creek fish was lightly infected with larval *Contracaecum* sp. in the mesenteries. Larval *Tetracotyle* sp. occurred lightly in the mesenteries in the 1 McCann creek fish. The 1 McKenzie creek mudminnow was lightly parasitized with larval *Clinostomum marginatum.*

Northern pike (Table 11)

All 40 northern pike were parasitized. Fischthal (1947) examined four pike from Little Long lake in 1944, recording similar parasites as shown in Table 11 with the exception of the larval *Clinostomum marginatum* which he did not find. In addition to the parasites found in common he observed *Macroderoides flavus.*

Great Lakes muskellunge (Table 12)

All seven muskellunge were parasitized. The Myxosporidia occurred on the gills of fish from the Chippewa and Ladysmith Flowages and on the roof of the mouth of the Lower Clam lake fish. The adult *Philometra* sp., taken from the body cavity of the Lower Clam lake muskellunge, measured 18.3 inches in length. Fischthal (1950) found smaller specimens of the same species of *Philometra* in Teal lake, Sawyer county, Wisconsin and mentions having observed Dr. R. V. Bangham recover specimens about two feet in length from muskellunge taken in northeast Wisconsin lakes.

Fundulus diaphanus menona Jordan and Copeland, Western banded killifish: The 4 Wapogasset creek fish were all lightly parasitized, 1 with larval *Diplostomulum* sp. in the lens of the eye, 2 with larval *Leptorhynchoides thecatus,* 1 with larval *Neascus* sp., 1 with adult and 4 with larval *Pomphorhynchus bulbocolli;* and 1 with larval *Posthodiplostomum minimum.*

Percopsis omiscomaycus (Walbaum), Troutperch: The 2 Chippewa river fish were lightly parasitized, 1 with *Crepidostomum isostomum,* 2 with larval *Diplostomulum* sp. in the lens of the eye, 1 with Gyrodactyloidea, 1 with larval *Neascus* sp., and 1 with larval *Triaenophorus stizostedionis* in 2 cysts on the liver.

Yellow perch (Table 13)

The yellow perch were 93.4 per cent infected (114 out of 122). The immature *Contracaecum* sp. occurred in the liver. The larval *Contracaecum* sp., *Leptorhynchoides thecatus,* and *Spiroxys* sp. were located in the mesenteries. The larval *Diplostomulum* sp. (1) occurred in the lens of the eye of Long lake (Washburn county) and Wapogasset creek perch, whereas *Diplostomulum* sp. (2) was taken from the humors. The Myxosporidia were observed on the gills of perch from Sauntry's Pocket. The immature *Proteocephalus* sp. from Ellison lake did not possess an apical sucker on its scolex. *Trichodina* sp. occurred on the gills.

Walleye (Table 14)

All 85 walleyes harbored parasites. *Bunodera sacculata* is probably accidental in the intestine of Long lake (Washburn county) walleyes. This trematode seems limited to the perch and since many perch harboring the parasite were removed from the stomachs of the walleyes, those *B. sacculata* found in the latter host were probably liberated from the intestine of the digested perch. The larval *Contracaecum* sp. was encysted in the mesentery. The Myxosporidia were in cysts on the gills. The immature *Proteocephalus* sp. from a Siskowitt lake fish did not possess an apical sucker on its scolex.

Boleosoma nigrum eulepis Hubbs and Greene, Scaly Johnny darter: The 3 Wapogasset creek fish were all infected, 1 lightly with immature *Dichelyne cotylophora,* 1 with larval *Diplostomulum* sp. in the lens of the eye, 3 with larval *Neascus* sp. and 1 with *Pomphorhynchus bulbocolli;* 1 had Myxosporidia occurring moderately on the gills.

Central x Scaly Johnny darter hybrid (Table 15)

Twenty-six (78.8 per cent) of the 33 hybrid Johnny darters were parasitized. The immature *Contracaecum* sp. occurred in the liver, while the larval stage was encysted in the mesenteries. The Myxosporidia was recovered from a cyst in the flesh.

Iowa darter (Table 16)

Twenty-two (95.7 per cent) of the 23 Iowa darters had parasites. The immature *Contracaecum* sp. was removed from the liver. The larval *Diplostomulum* sp. was from the lens of the eye. The larval *Leptorhynchoides thecatus, Pomphorhynchus bulbocolli* and *Tetracotyle* sp. were in the mesenteries. The Myxosporidia also occurred in cysts in the mesenteries.

Poecilichys flabellaris lineolatus (Agassiz), Striped fantail: Twelve (60 per cent) of 20 fantails were infected. Two of the 5 from the Chippewa river were lightly parasitized, 1 with immature *Azygia augusticauda,* 1 with larval *Contracaecum* sp. in the mesentery, and 1 with larval *Neascus* sp. The 4 Duncan creek fish harbored larval *Neascus* sp., 3 lightly and 1 moderately. Six of the 11 Little Bear creek fish were infected, 2 lightly with immature *Contracaecum* sp. in the liver, and 4 lightly, 1 moderately with larval *Neascus* sp.

Northern smallmouth bass (Table 17)
Largemouth bass (Table 18)

Seventy-five (97.4 per cent) of the 77 largemouth bass were parasitized. The immature *Contracaecum* sp. was taken from the intestine, while the larval stage was encysted in the mesenteries. The larval *Diplostomulum* sp. was in the lens of the eye. The larval *Leptorhynchoides thecatus* and *Spiroxys* sp. occurred in the mesenteries. *Trichodina* sp. was observed on the gills. The immature *Proteocephalus* sp. from Dells Pond did not possess an apical sucker on its scolex.

Lepomis cyanellus Raf., Green sunfish: All 4 from 2 waters harbored parasites. The 2 Little Bear creek fish were lightly infected with Gyrodactyloidea. The 2 Simms lake sunfish were parasitized, 1 lightly with larval *Neascus* sp., 1 with larval *Proteocephalus ambloplitis,* and 1 with *Spinitectus carolini;* also, 1 lightly and 1 moderately with *Leptorhynchoides thecatus.*

Pumpkinseed (Table 19)

The pumpkinseeds were 98.2 per cent parasitized. The immature *Contracaecum* sp. occurred in the intestine, while the larval stage was encysted in the mesentery. The larval *Leptorhynchoides thecatus, Neoechinorhynchus* sp., *Proteocephalus* sp., *Spiroxys* sp., *Tetracotyle* sp., and *Triaenophorus nodulosus* were located in the mesenteries. The Myxosporidia were observed in cysts on the consus arteriosus.

Common bluegill (Table 20)

Of the 220 bluegills examined, 206 (93.6 per cent) were parasitized. The larval *Diplostomulum* sp. was observed in the lens of the eye. The larval *Leptorhynchoides thecatus* and *Spiroxys* sp. were in the mesenteries. The immature *Proteocephalus* sp. did not possess an apical sucker on its scolex.

Northern rock bass (Table 21)

Seventy (97.2 per cent) of the 72 rock bass had parasites. The larval *Proteocephalus* sp. was encysted in the mesentery and possessed an apical sucker on its scolex.

Black crappie (Table 22)

Approximately 89.5 per cent (205 out of 229) black crappies were infected with at least one species of parasite. The larval *Contracaecum* sp., *Leptorhynchoides thecatus* and *Spiroxys* sp. were encysted in the mesenteries. The Myxosporidia on the crappie from Clear Lake occurred in cysts on the gills, while those from the other waters parasitized had the cysts on the intestinal wall.

Cottus b. bairdii Girard, Northern muddler: Eleven (92 per cent) of the 12 fish from 2 creeks were infected. One of 2 Devils creek fish harbored a light infection of *Rhabdochona cascadilla.* The 10 Duncan creek fish were lightly parasitized, 1 with *Neoechinorhynchus rutili,* 9 with *R. cascadilla,* and 6 with larval *Tetracotyle* sp.

Eucalia inconstans (Kirtland), Brook stickleback: Only 8 (38 per cent) of 21 fish were parasitized. The 2 Duncan creek fish were infected, 2 lightly with immature *Bunoderina eucaliae,* and 1 with larval *Spiroxys* sp. The 1 McCann creek fish was lightly infected with larval *Neascus* sp. and larval *Proteocephalus* sp. Only 2 of the 14 Osceola creek fish harbored a light infection with *B. eucaliae.* Three of the 4 Wapogasset creek fish were lightly parasitized, 2 with larval *Leptorhynchoides thecatus,* 3 with larval *Pomphorhynchus bulbocolli,* and 1 with larval *Proteocephalus* sp.

Pungitius pungitius (Linn.), Ninespine stickleback: All 7 Lake Superior fish were parasitized, 2 lightly and 1 moderately with immature *Bothriocephalus* sp., 1 lightly with larval *Contracaecum* sp., 5 with larval *Diplostomulum* sp. in the lens of the eye, 1 with larval glochidia, 2 with *Leptorhynchoides thecatus,* 7 with larval *Ligula intestinalis,* and 1 with larval *Tetracotyle* sp.

TABLE 3

Amia calva Linn.—BOWFIN

	HALF MOON L.	MUD HEN L.	ST. CROIX L.
Examined 8 Infected 8	1 1	3 3	4 4
Azygia augusticauda	....	....	1^{1} 1^{2}
***Bothriocephalus* sp.	....	....	2^{1}
***Camallanus oxycephalus*	1^{1}	....	....
Contracaecum brachyurum	1^{1}	....	....
**Diplostomulum* sp.	....	1^{1}	....
Haplobothrium globuliforme	1^{2}	1^{1}	2^{1}
Leptorhynchoides thecatus	1^{1}	....	....
Macroderoides parvus	....	2^{2} 1^{3}	2^{2} 1^{3}
Proteocephalus ambloplites	.... 1^{2}	2^{1}	.... 1^{2}
⊥*Proteocephalus ambloplites*	....	1^{2}	2^{2}
***Proteocephalus ambloplites*	....	....	1^{1}

TABLE 4

Catostomas c. commersonnii (Lac.)—COMMON WHITE SUCKER

	BIG FALLS FL.	CHENAQUA L.	CHIPPEWA R.	DELLS PD.	DEVILS CR.	DUNCAN CR.	GRANITE L.	HALF MOON L.	HAY CREEK PD.	KNUTESON CR.	LADYSMITH FL.	LITTLE BEAR CR.	LONG L. (W)	McKENZIE CR.	MONDEAUX FL.	MOOSE L.	MUD HEN L.	ST. CROIX L.	SAUNTRY'S POCKET	SIMMS L.	SISKOWITT L.	UPPER CLAM L.	WHITE BASS L.
Examined 89	1	2	3	8	3	5	1	1	5	4	3	6	10	1	9	8	1	1	2	4	3	3	5
Infected 76	1	0	2	8	1	4	1	1	5	4	3	5	10	0	8	8	1	1	2	3	0	3	5
Caryophyllaeidae								1¹															
**Contracaecum sp.										2¹													
*Diplostomulum sp.													1¹ 8²				1¹		1¹				
Glaridacris catostomi				2¹	1¹	2¹						1¹	2¹ 1²			1¹							2¹
ıGlaridacris catostomi				2¹									1²										2¹
**Glaridacris catostomi									2¹		1¹				1¹ 2²		1¹	1¹	1¹ 1²				1¹
Glaridacris confusus							1¹			1¹													
*Glochidia													2¹										
Hepaticola bakeri																			1¹				
Leptorhynchoides thecatus													3¹							3¹			
Myxosporidia					1¹											1¹ 2²							
*Neascus sp.			1¹	7¹		2¹				1¹		2¹											
Neoechinorhynchus crassus				1¹			1¹		1¹ 4³	4¹		1¹ 1²	2¹		2¹	6¹		1¹					2¹ 1²
Phyllodistomum lysteri											1¹					4¹ 1²	1²					2¹	1¹ 1²
Pomphorhynchus bulbocolli			1¹							2¹	1¹ 2²											1¹ 2²	1¹
*Triaenophorus nodulosus	1¹										1¹				4¹	2¹ 4²						3¹	3¹
Triganodistomum attenuatum				2¹					1¹														2¹
**Triganodistomum attenuatum			1¹			1¹	1¹					1¹											

TABLE 5

Moxostoma rubreques Hubbs—GREATER REDHORSE

	BIG FALLS FL.	DELLS PD.	LADYSMITH FL.	LOWER CLAM L.	MOOSE L.	ST. CROIX L.
Examined 14	1	1	2	4	5	1
Infected 14	1	1	2	4	5	1
*Clinostomum marginatum					3¹	
*Diplostomulum sp.					1¹	
Glaridacris catostomi				1¹		
⊥Glaridacris catostomi		1¹				
			1²			
Glaridacris confusus			1¹			
**Glaridacris confusus					2¹	
*Glochidia					2¹	
Gyrodactyloidea					1¹	
Myxosporidia					1³	
*Neascus sp.		1¹				
Neoechinorhynchus crassus				2¹	2¹	1¹
Pomphorhynchus bulbocolli				3¹		
Rhabdochona cascadilla				3¹	1¹	
*Triaenophorus nodulosus	1¹			2¹	2¹	
Triganodistomum attenuatum				1¹	1¹	

TABLE 6

Semotilus a. atromaculatus (Mitchill)—NORTHERN CREEK CHUB

	DEVILS CR.	DUNCAN CR.	KNUTESON CR.	LITTLE BEAR CR.	McCANN CR.	OSCEOLA CR.	SOMERS CR.	WAPOGASSET CR.
Examined 37	2	2	12	1	1	13	4	2
Infected 34	2	2	11	1	1	11	4	2
Allocreadium lobatum	2¹				1¹			
⊥Allocreadium lobatum						1¹		
								1²
**Allocreadium lobatum		1¹				5¹	2¹	
**Camallanus oxycephalus								1¹
**Contracaecum sp.			1¹					
*Diplostomulum sp.								2²
*Glochidia								2¹
*Neascus sp.			9¹					2¹
		1²		1²	1²		2²	
		1³						
Neoechinorhynchus saginatus		1¹						1¹
*Posthodiplostomum minimum		1¹	3¹		1¹	7¹		
								1²
Rhabdochona cascadilla			1¹		1¹		1¹	

TABLE 7

Notemigonus crysoleucas auratus (Raf.)—WESTERN GOLDEN SHINER

	CHIPPEWA FL.	HALF MOON L.	LITTE CLAM L.	SPRING L.	WHITE BASS L.
Examined 22 Infected 18	1 1	4 0	4 4	12 12	1 1
Ergasilus sp.	......	......	......	9[1] 1[1]	......
Gyrodactyloidea	......	......	4[1]	......	......
**Neascus* sp.	1[1]	......	4[1]	9[2] 3[3]	1[2]
Neoechinorhynchus rutili	......	......	......	1[1]	......
Plagiocirrus primus	......	......	......	11[1] 1[1]	......
Pliovitellaria wisconsinensis	......	......	1[1]	......	......

TABLE 8

Notropis cornutus frontalis (Agassiz)—NORTHERN COMMON SHINER

	KNUTESON CR.	MCCANN CR.	WAPOGASSET CR.
Examined 13 Infected 13	4 4	1 1	8 8
***Allocreadium lobatum*	......	......	6[1] 1[2]
Caryophyllaeidae	1[1]	......	......
**Diplostomulum* sp.	......	......	3[1] 2[2]
*Glochidia	......	......	3[1]
Gyrodactyloidea	......	......	1[1]
Myxosporidia	......	......	2[1]
**Neascus* sp.	......	1[1]	1[1]
**Posthodiplostomum minimum*	3[1]	......	6[1] 2[2]
Rhabdochona cascadilla	2[1]	1[2] 1[1]	4[1]

TABLE 9

Ameiurus n. nebulosus (Le Sueur)—NORTHERN BROWN BULLHEAD

	Chenaqua L.	Clear L.	Granite L.	Half Moon L.	Hay Creek Pd.	Knuteson Cr.	Little Bear Cr.	Little Clam L.	Long L. (W)	Mondeaux Fl.	Pelican L.	White Bass L.
Examined 44	7	7	1	1	11	1	2	4	3	1	5	1
Infected 32	1	7	1	1	11	1	1	4	3	1	0	1
⊥*Allocreadium ictaluri*												1^1
***Alloglossidium corti*									1^2 2^3			
Alloglossidium geminus		5^2 1^3			2^2					1^2		
⊥*Alloglossidium geminus*			1^1									
***Azygia augusticauda*									1^1			
***Bothriocephalus cuspidatus*									1^1			
**Clinostomum marginatum*									1^1			
***Contracaecum* sp.					2^1				2^1			
**Contracaecum* sp.					1^1 1^2							
Corallobothrium fimbriatum				1^1								
***Corallobothrium fimbriatum*		2^1	1^1		3^1			1^1		1^1		
Dichelyne robusta		5^1 2^2	1^1					3^1				
**Diplostomulum* sp.		5^1							3^1			
*Glochidia									2^1			
Gyrodactyloidea	1^1		1^1	1^1	9^1	1^1		4^1				
Leptorhynchoides thecatus		2^1	1^1						1^1			1^1
Phyllodistomum staffordi		1^1	1^1		6^1 1^1			3^1 1^2	1^1			1^1
**Pomphorhynchus bulbocolli*						1^1						
**Proteocephalus ambloplitis*		2^1 5^2	1^1						2^2 1^3	1^1		
**Proteocephalus* sp.						1^1						
***Proteocephalus stizostethi*									1^1			
Rhabdochona sp.					1^1							
Spinitectus gracilis			1^1									
**Spiroxys* sp.							1^1					

TABLE 10

Ameiurus n. natalis (Le Sueur)—NORTHERN YELLOW BULLHEAD

	CHIPPEWA FL.	LITTLE GRANITE L.	SAUNTRY'S POCKET
Examined 22	1	6	15
Infected 22	1	6	15
Alloglossidium corti	…	…	1[1]
***Contracaecum* sp.	…	…	9[1]
***Crepidostomum cooperi*	…	1[1]	…
Dichelyne robusta	…	6[1]	…
**Diplostomulum* sp.	…	…	1[1]
Gyrodactyloidea	1[1]	2[1] 4[2]	1[1] 13[2] 1[3]
Myxosporidia	…	…	3[1]
Phyllodistomum staffordi	…	4[1]	…
**Posthodiplostomum minimum*	…	…	1[1]
**Proteocephalus ambloplitis*	…	1[1]	…
**Spiroxys* sp.	…	…	4[1]

TABLE 11

Esox lucius Linn.—NORTHERN PIKE

	BEAVER DAM L.	CLEAR L.	GRANITE L.	HALF MOON L.	LITTLEBEAR CR.	LITTLE LONG L.	LONG L. (W)	MUD HEN L.	ST. CROIX L.
Examined 40	12	1	1	2	4	10	7	2	1
Infected 40	12	1	1	2	4	10	7	2	1
Azygia augusticauda	2^{1}	....	....	....	....	4^{1}	....	....	....
⊥*Azygia augusticauda*	....	....	....	....	....	1^{1}	....	....	....
***Azygia augusticauda*	2^{1}	....	1^{1}	....	....	....	3^{1}	....	....
Camallanus oxycephalus	1^{1}	....	....	....	....	....	....	....	....
**Clinostomum marginatum*	....	....	....	....	....	1^{1}	....	....	....
Contracaecum brachyurum	4^{1}	....	....	....	....	....	....	....	....
⊥*Contracaecum brachyurum*	2^{1} 3^{2}	....	....	....	....	2^{1}	1^{1} 6^{2}	....	....
***Contracaecum brachyurum*	2^{1} 1^{2}	....	....	....	2^{2}	5^{1}	....	....	....
**Diplostomulum scheuringi*	3^{1}	.... 1^{2}	....	....	....	9^{1}	5^{1}	2^{1}	....
*Glochidia	3^{1}	....	....	....	....	....	5^{1}	....	....
Gyrodactyloidea	3^{1} 4^{2} 5^{3}	....	.... 1^{3}	....	3^{1} 1^{2}	7^{1} 1^{2} 2^{3}	1^{1} 3^{2} 2^{3}	2^{1}	1^{1}
Leptorhynchoides thecatus	1^{1}	....	....	2^{1}	....	....	5^{1}	....	....
**Neascus* sp.	.... 5^{2} 6^{3}	1^{1}	1^{1}	....	....	6^{1} 3^{2} 1^{3}	1^{1} 5^{2} 1^{3}	.... 2^{2}	.... 1^{3}
Neoechinorhynchus tenellus	....	....	....	1^{1}	....	....	....	....	....
Proteocephalus pinguis	....	....	....	1^{1}	....	....	....	....	1^{1}
⊥*Proteocephalus pinguis*	4^{2} 8^{3}	....	....	1^{2}	....	3^{2} 2^{3}	3^{2} 3^{3}	....	....
***Proteocephalus pinguis*	....	....	.... 1^{3}	....	1^{1} 2^{2} 1^{3}	1^{1} 3^{2}	....	1^{1}	....

TABLE 12

Esox m. masquinongy Mitchill—GREAT LAKES MUSKELLUNGE

	BIG FALLS FL.	CHIPPEWA FL.	LADYSMITH FL.	LOWER CLAM L.	WHITE BASS L.
Examined 7	1	1	3	1	1
Infected 7	1	1	3	1	1
***Camallanus oxycephalus*	1^{1}	......	......	......	......
		1^{2}			
Gyrodactyloidea	......	......	1^{1}	......	......
Leptorhynchoides thecatus	......	......	......	......	1^{1}
Macroderoides flavus	......	......	......	1^{1}	......
Myxosporidia	......	......	......	1^{1}	......
		1^{3}	1^{3}		
**Neascus* sp.	......	......	1^{1}	......	......
Neoechinorhynchus tenellus	......	1^{1}	1^{1}	......	......
Philometra sp.	......	......	......	1^{1}	......
Phyllodistomum sp.	1^{1}	......	1^{1}	......	......
			1^{3}		
***Phyllodistomum* sp.	......	......	1^{1}	......	......
⊥*Proteocephalus pinguis*	......	1^{3}	......	......	......
Spinitectus carolini	......	......	2^{1}	......	......
Spinitectus gracilis	......	1^{1}	1^{1}	......	......
⊥*Triaenophorus nodulosus*	1^{1}	1^{1}	......	......	1^{1}
***Triaenophorus nodulosus*	......	......	1^{1}	1^{1}	......

TABLE 13

Perca flavescens (Mitchill)—YELLOW PERCH

	ASHEGON L.	CHENAQUA L.	CHIPPEWA FL.	CHIPPEWA R.	DELLS PD.	ELLISON L.	FAIRCHILD PD.	HALF MOON L.	LITTLE BEAR CR.	LITTLE LONG L.	LONG L. (1)
Examined 122 Infected 114	3 3	9 3	9 9	3 3	1 1	12 12	7 6	10 9	1 1	11 11	6 6
***Bothriocephalus cuspidatus*	....	....	3^1	....	....	4^1	....	....	....	....	....
Bunodera sacculata	....	....	3^1	....	....	2^1	....	....	....	....	....
Camallanus oxycephalus	....	....	....	....	....	7^1	....	....	....	....	....
***Camallanus oxycephalus*	....	....	2^1	....	....	3^1	....	2^1	....	....	....
**Clinostomum marginatum*	....	....	....	1^1	....	9^1	....	....	....	....	....
***Contracaecum* sp.	....	....	....	....	....	4^1	....	....	....	5^1	5^1
**Diplostomulum scheuringi*	....	....	1^1	1^1	....	7^1	1^1	....	....	4^1	....
**Diplostomulum* sp. (2)	....	....	1^1 4^2 4^3	3^1	1^1	....	....	....	1^1	....	....
*Glochidia	....	....	1^1	....	....	....	....	....	....	....	....
Gyrodactyloidea	....	2^1	8^1	3^1	1^1	7^1 4^2	....	....	....	5^1 6^2	2^1
Leptorhynchoides thecatus	....	....	....	....	....	....	....	1^1	....	....	....
**Neascus* sp.	3^1	1^1	....	2^1 1^2	.... 1^3	4^1 2^2 1^3	2^1 2^2 2^3	4^1	.... 1^2	6^1 5^2	3^1 3^2
Neoechinorhynchus cylindratus	....	....	1^1	....	....	....	....	3^1	....	....	....
***Proteocephalus pearsei*	....	....	....	1^1	....	....	....	1^1	....	1^1 8^2	....
***Proteocephalus* sp.	....	....	....	....	....	2^1	....	....	....	....	....
***Proteocephalus stizostethi*	....	....	1^1	....	....	....	....	....	....	5^1	....
Spinitectus carolini	3^1	....	....	....	1^1	....	....	....	....	....	....
Spinitectus gracilis	....	....	....	....	....	....	1^1	....	....	....	....

TABLE 13—*(Continued)*

Perca flavescens (Mitchill)—YELLOW PERCH

	LONG L. (W)	MONDEAUX FL.	MUD HEN L.	PELICAN L.	SAUNTRY'S POCKET	SIMMS L.	SISKOWITT L.	WAPOGASSET CR.	WHITE BASS L.
	8 8	10 10	4 4	1 1	20 20	1 1	3 3	2 2	1 1
***Bothriocephalus cuspidatus*	3^{1}	....	....	1^{1}	....	....	....	....	....
Bunodera sacculata	3^{1}	....	1^{1}	....	14^{1}	....	....	....	....
⊥*Bunodera sacculata*	....	....	....	....	2^{1}	....	....	....	1^{1}
***Bunodera sacculata*	....	....	....	....	1^{1}	....	....	....	....
***Camallanus oxycephalus*	....	4^{1}	....	....	....	....	....	....	....
**Clinostomum marginatum*	1^{1}	9^{1}	2^{1}	....	....	....	....	....	1^{1}
***Contracaecum* sp.	....	....	.... 4^{2}	....	14^{1} 6^{2}	....	....	....	1^{1}
**Contracaecum* sp.	1^{1}	....	....	....	....	....	....	....	....
Dichelyne cotylophora	....	....	4^{1}	....	....	....	....	....	1^{1}
**Diplostomulum scheuringi*	....	1^{1}	1^{1} 3^{2}	....	11^{1}	1^{1}	2^{1}	....	....
**Diplostomulum* sp. (1)	3^{1}	....	....	....	....	....	....	1^{1}	....
**Diplostomulum* sp. (2)	.... 4^{2} 4^{3}	....	1^{1}	....	3^{1}	....	....	....	....
*Glochidia	4^{1}	....	....	....	8^{1}	....	....	....	....
Gyrodactyloidea	5^{1} 2^{2}	....	....	....	9^{1} 8^{2} 1^{3}	1^{1}	.... 3^{2}	1^{1}	1^{1}
Illinobdella sp.	....	....	....	....	3^{1}	....	....	1^{1}	....
Leptorhynchoides thecatus	3^{1}	....	2^{1}	....	....	....	....	....	....
**Leptorhynchoides thecatus*	....	....	....	....	....	1^{1}	....	....	....
**Ligula intestinalis*	....	....	....	....	....	....	....	1^{1}	....
Myxosporidia	....	....	....	....	3^{1}	....	....	....	....
**Neascus* sp.	.... 8^{2}	6^{1}	4^{1}	....	10^{1} 5^{2}	.... 1^{2}	1^{1}	2^{1}	1^{1}
Neoechinorhynchus cylindratus	....	1^{1}	....	....	....	....	....	....	....
**Proteocephalus ambloplitis*	1^{1}	....	....	....	....	....	....	1^{1}	....
***Proteocephalus pearsei*	2^{1}	....	1^{1}	....	8^{1} 8^{2}	....	....	....	....
***Proteocephalus stizostethi*	3^{1} 3^{2}	....	....	....	....	....	....	....	....
Spinitectus gracilis	....	....	....	....	....	....	3^{1}	....	....
**Spiroxys* sp.	2^{1}	....	....	....	....	....	....	....	....
Trichodina sp.	....	....	....	....	3^{1} 4^{2} 2^{3}	....	....	.... 1^{2}	....

TABLE 14

Stizostedion v. vitreum (Mitchill)—WALLEYE

	BEAVER DAM L.	BIG FALLS FL.	CHIPPEWA FL.	ELLISON L.	GRANITE L.	HALF MOON L.	LADYSMITH FL.
Examined 85 Infected 85	12 12	1 1	13 13	4 4	2 2	9 9	5 5
Argulus versicolor	1^{1}	......	......	......	......	......	......
***Azygia augusticauda*	1^{1}	......	......	......	......	......	......
Bothriocephalus cuspidatus	......	......	1^{1}	......	......	2^{1} 1^{2}	5^{1}
⊥*Bothriocephalus cuspidatus*	2^{2} 7^{3}	1^{1}	4^{2} 2^{3}	2^{2}	2^{2}	3^{1} 2^{2}	......
***Bothriocephalus cuspidatus*	3^{3}	......	1^{1} 1^{2} 1^{3}	1^{1} 1^{2}	......	1^{1}	......
Bucephalopsis pusilla	......	......	......	......	1^{1}	......	1^{1}
Camallanus oxycephalus	5^{1}	......	......	2^{1} 2^{2}	1^{1}	2^{1}	......
⊥*Camallanus oxycephalus*	3^{1}	......	1^{2}	......	1^{2}	......	......
***Camallanus oxycephalus*	1^{1}	......	3^{1} 4^{2} 2^{3}	......	......	1^{1}	......
**Clinostomum marginatum*	......	......	......	......	1^{1}	......	......
***Contracaecum brachyurum*	7^{1}	......	......	1^{1}	......	......	......
**Diplostomulum scheuringi*	7^{1}	......	......	......	......	......	......
*Glochidia	......	......	1^{1}	......	......	......	......
Gyrodactyloidea	......	......	3^{1} 2^{2}	......	......	......	5^{1}
Illinobdella sp.	......	......	1^{1}	......	......	......	......
Leptorhynchoides thecatus	2^{1}	......	......	......	......	......	......
Lymphocystis	1^{2} 2^{3}	......	2^{2}	......	......	......	......
Myxosporidia	......	......	1^{2}	......	......	......	......
**Neascus* sp.	5^{1} 3^{2} 1^{3}	1^{1}	......	......	2^{1}	......	3^{1} 2^{2}
Neoechinorhynchus tenellus	......	1^{1}	1^{1} 7^{2} 4^{3}	......	......	1^{1} 8^{2}	3^{1} 1^{2} 1^{3}
Proteocephalus stizostethi	......	......	4^{1} 1^{2}	......	......	......	1^{1}
⊥*Proteocephalus stizostethi*	......	......	3^{1}	......	......	......	......
***Proteocephalus stizostethi*	......	......	3^{1}	......	......	......	......
Sanguinicola occidentalis	3^{1}	......	......	......	1^{1}	......	......
Spinitectus carolini	......	......	......	......	......	......	2^{1}
⊥*Triaenophorus stizostedionis*	......	......	1^{1} 2^{2}	......	......	......	......
***Triaenophorus stizostedionis*	......	......	2^{1}	......	......	......	......

TABLE 14—*(Continued)*

Stizostedion v. vitreum (Mitchill)—WALLEYE

	Little Long L.	Long L. (1)	Long L. (W)	Lower Clam L.	Mondeaux Fl.	Moose L.	Siskowitt L.	Upper Clam L.
	4 4	2 2	12 12	3 3	1 1	3 3	10 10	4 4
Allocreadium lobatum	1^{1}							
***Azygia augusticauda*			2^{1}					
Bothriocephalus cuspidatus		1^{1}					4^{1} 3^{2}	3^{1}
⊥*Bothriocephalus cuspidatus*	3^{2}	1^{2}		1^{2}				1^{2}
***Bothriocephalus cuspidatus*	1^{1}		4^{3} 1^{1} 3^{2}			1^{1}	2^{1}	
***Bucephalopsis pusilla*			4^{3} 1^{1} 3^{2}	1^{1}				
Bunodera sacculata			2^{1}					
⊥*Camallanus oxycephalus*						3^{2}		
***Camallanus oxycephalus*					1^{1}			
**Clinostomum marginatum*			1^{1}	2^{1}	1^{1}			
⊥*Contracaecum brachyurum*			3^{1} 7^{2}					
***Contracaecum brachyurum*			1^{1}					
**Contracaecum* sp.					1^{1}			
**Diplostomulum scheuringi*	2^{1}		10^{1}					
*Glochidia			3^{1} 3^{2} 6^{3}					
Gyrodactyloidea		2^{2}	3^{1} 6^{2} 1^{3}	2^{2} 1^{3}		3^{1}		3^{1} 1^{2}
Illinobdella sp.			1^{1}					
Leptorhynchoides thecatus			5^{1}					
**Neascus* sp.	1^{1} 3^{2}	2^{2}	1^{1} 10^{2} 1^{3}	3^{1}	1^{1}			4^{1}
Neoechinorhynchus tenellus				2^{1}	1^{1}	1^{1} 2^{2}		3^{1} 1^{2}
***Proteocephalus ambloplitis*			1^{1}					
***Proteocephalus* sp.							1^{1}	
Proteocephalus stizostethi	2^{1}					1^{1}		
⊥*Proteocephalus stizostethi*			6^{1} 5^{2}			1^{1}		
***Proteocephalus stizostethi*	1^{1}		1^{1}	3^{1}				
Sanguinicola occidentalis							2^{1}	
Spinitectus gracilis				1^{1}		1^{1}		
⊥*Triaenophorus stizostedionis*						1^{2}		
***Triaenophorus stizostedionis*				1^{1}				

TABLE 15

Boleosoma n. nigrum x *B. n. eulepis*—CENTRAL x SCALY JOHNNY DARTER HYBRID

	CHIPPEWA R.	DEVILS CR.	DUNCAN CR.	KNUTESON CR.	LITTLE BEAR CR.	SOMERS CR.
Examined 33 Infected 26	2 2	3 3	11 11	3 1	12 7	2 2
Bothriocephalus formosus	......	1[1] 1[2]	4[1]	......	4[1]	1[1]
***Contracaecum* sp.	......	......	......	1[1]	1[1]	......
**Contracaecum* sp.	1[1]	1[1]	......	......	......	......
Crepidostomum isostomum	......	......	......	......	......	1[1]
Leptorhynchoides thecatus	......	......	......	1[1]	......	......
Myxosporidia	......	......	1[1]	......	......	......
**Neascus* sp.	......	1[1]	11[1]	......	3[1]	......
Neoechinorhynchus sp.	1[1]	......	......	......	......	......
Phyllodistomum etheostomae	......	......	2[1]	......	......	......
**Tetracotyle* sp.	......	......	......	1[1]	......	......

TABLE 16

Poecilichthys exilis (Girard)—IOWA DARTER

	SAUNTRY'S POCKET	WAPOGASSET CR.
Examined 23 Infected 22	16 16	7 6
Azygia augusticauda	1[1]	....
***Contracaecum* sp.	9[1] 7[2]	....
**Diplostomulum scheuringi*	1[1]	....
**Diplostomulum* sp.	....	2[1]
**Leptorhynchoides thecatus*	....	6[1]
Myxosporidia	3[1] 5[2]	....
**Neascus* sp.	3[1]	1[1]
Pomphorhynchus bulbocolli	....	2[1]
**Pomphorhynchus bulbocolli*	....	3[1]
**Tetracotyle* sp.	2[1]	....

TABLE 17

Micropterus d. dolomieu Lac.—NORTHERN SMALLMOUTH BASS

	BEAVER DAM L.	BIG FALLS FL.	LADYSMITH FL.	LONG L. (2)	WEST TWIN L.
Examined 19	1	6	8	1	3
Infected 19	1	6	8	1	3
Caecincola parvulus	1[1]	1[1]	......	......	......
***Camallanus oxycephalus*	1[1]	5[1]	......	......	......
Crepidostomum cooperi	......	2[1] 1[2] 2[3]	......	......	......
Crepidostomum cornutum	......	......	4[1] 2[2]	......	......
**Diplostomulum scheuringi*	1[1]	......	......	......	......
Ergasilus caeruleus	1[1]	1[1]	......	......	......
Gyrodactyloidea	......	6[1]	......	......	......
Leptorhynchoides thecatus	......	1[1]	......	......	......
**Neascus* sp.	1[2] ...... 1[3]	2[1]	5[1]	1[1]	2[1]
Neoechinorhynchus cylindratus	......	4[1] 1[2]	7[1] 1[2]	......	......
***Proteocephalus ambloplitis*	1[1]	......	......	......	......
**Proteocephalus ambloplitis*	...... 1[3]	......	......	1[1]	3[1]
Proteocephalus fluviatilis	......	......	......	......	1[1]
⊥*Proteocephalus fluviatilis*	......	1[1]	......	1[1]	1[1]
***Proteocephalus fluviatilis*	......	5[1]	......	......	1[1]
Rhipidocotyle papillosum	......	1[1]	......	......	......
Spinitectus carolini	......	......	4[1] 4[2]	......	......
Spinitectus gracilis	......	2[1] 4[2]	......	......	......
**Spiroxys* sp.	......	......	......	......	1[1]

TABLE 18

Micropterus salmoides (Lac.)—LARGEMOUTH BASS

	BEAVER DAM L.	CHENAQUA L.	CHIPPEWA FL.	CLEAR L.	DELLS PD.	EAST TWIN L.	ELLISON L.	GRANITE L.	KNUTESON CR.
Examined 77	2	5	5	11	8	5	4	1	1
Infected 75	2	5	5	11	8	5	4	1	1
Achtheres micropteri	1^1	....	....	1^1	....	....	....	1^1	....
***Azygia augusticauda*	1^1	....	....	....	....	....	....	....	....
Caecincola parvulus	1^1	....	....	1^1 8^2 2^3	....	....	....	....	....
⊥*Camallanus oxycephalus*	....	....	....	3^1	....	....	....	....	....
***Camallanus oxycephalus*	....	....	3^1	....	2^1	....	....	....	....
**Clinostomum marginatum*	1^1	....	2^1	....	....	....	....	....	....
***Contracaecum* sp.	1^1 1^2	....	1^1	....	....	....	....	....	....
Crepidostomum cooperi	2^1	....	....	....	....	....	....	....	....
**Diplostomulum scheuringi*	1^1	....	....	....	....	....	....	....	....
Ergasilus caeruleus	....	....	....	....	2^1	....	....	....	....
*Glochidia	....	....	1^1	....	....	....	....	....	....
Gyrodoctyloidea	.... 1^2 1^3	1^1 4^2	.... 5^3	.... 11^2	2^1 6^2	1^1	2^1 2^2	.... 1^3	1^1
Leptorhynchoides thecatus	....	....	....	7^1 4^2	....	....	....	1^1	1^1
**Neascus* sp.	1^1 1^2	....	....	4^1 6^2 1^3	.... 5^2 3^3	....	2^1 2^2	1^1	....
Neoechinorhynchus cylindratus	.... 1^2 1^3	....	2^1	....	....	....	....	.... 1^3	....
Proteocephalus ambloplitis	....	....	....	3^1	....	....	....	....	....
***Proteocephalus ambloplitis*	1^1	....	2^1 1^2	....	....	....	....	....	....
**Proteocephalus ambloplitis*	.... 1^2 1^3	.... 4^2	....	.... 6^2 5^3	....	2^1 2^2 1^3	1^1 3^2	.... 1^2	....
***Proteocephalus fluviatilis*	....	....	....	....	1^1	....	....	....	....
Spinitectus carolini	....	....	....	....	5^1 1^2	....	....	....	....
Spiroxys sp.	1^1	....	....	....	....	....	....	....	....

TABLE 18—*(Continued)*

Micropters salmoides (Lac.)—LARGEMOUTH BASS

	Little Clam L.	Little Granite L.	Long L. (1)	Mud Hen L.	Pelican L.	St. Croix L.	Simms L.	Wapogasset Cr.	White Bass L.
	88	11	22	88	20	55	55	22	22
Achtheres micropteri	....	1^{1}	....	....	....	....	....	....	....
Azygia augusticauda	....	....	....	....	....	2^{1}	....	....	....
***Azygia augusticauda*	....	....	....	1^{1}	....	....	....	....	....
Caecincola parvulus	....	....	....	....	....	1^{1}	....	1^{1}	....
				4^{2}			5^{2}		
				2^{3}					
***Camallanus oxycephalus*	4^{1}	....	....	....	....	....	....	1^{1}	1^{1}
**Clinostomum marginatum*	....	1^{1}	....	....	....	....	....	1^{1}	....
**Contracaecum* sp.	....	....	....	....	....	....	....	1^{1}	....
⊥*Crepidostomum cooperi*	....	1^{3}	....	....	....	....	....	....	....
Crepidostomum cornutum	6^{1}	....	....	....	....	....	....	....	....
***Dichelyne cotylophora*	....	....	....	....	....	....	....	1^{1}	....
**Diplostomulum scheuringi*	....	....	....	5^{1}	....	....	....	....	....
**Diplostomulum* sp.	....	....	....	....	....	....	....	2^{1}	....
Ergasilus caeruleus	....	....	....	2^{1}	....	....	....	....	....
						1^{2}			
Gyrodactyloidea	6^{1}	....	....	3^{1}	....	....	1^{1}	....	....
	1^{2}		2^{2}	3^{2}		4^{2}	4^{2}		
		1^{3}				1^{3}			2^{3}
Illinobdella sp.	....	....	....	....	....	....	....	2^{1}	....
Leptorhynchoides thecatus	....	....	....	6^{1}	....	4^{1}	5^{1}	2^{1}	....
				1^{2}					
**Leptorhynchoides thecatus*	....	....	....	....	....	....	2^{1}	2^{1}	....
**Neascus* sp.	....	....	....	2^{1}	....	5^{1}	1^{1}	1^{1}	....
		1^{2}	2^{2}	6^{2}			4^{2}	1^{2}	2^{2}
Neoechinorhynchus cylindratus	8^{1}	....	....	8^{1}	....	2^{1}	1^{1}	....	....
			2^{2}						2^{2}
Pomphorhynchus bulbocolli	....	....	....	....	....	....	....	1^{1}	....
Proteocephalus ambloplitis	....	....	....	....	....	....	2^{1}	....	....
							1^{2}		
***Proteocephalus ambloplitis*	....	....	....	....	....	....	....	1^{1}	....
**Proteocephalus ambloplitis*	3^{1}	....	....	....	....	....	1^{1}	1^{1}	....
	2^{2}	1^{2}	2^{2}			3^{2}	1^{2}		
	1^{3}			8^{3}		2^{3}	3^{3}		
***Proteocephalus fluviatilis*	5^{1}	....	....	1^{1}	....	....	....	....	....
Spinitectus carolini	....	....	....	....	....	1^{1}	4^{1}	....	....
Spinitectus gracilis	....	....	1^{1}	....	....	....	....	....	....
**Spiroxys* sp.	7^{1}	....	....	....	....	....	....	....	....
Trichodina sp.	....	....	....	....	....	....	....	1^{1}	....

TABLE 19

Lepomis gibbosus (Linn.)—PUMPKINSEED

	Beaver Dam L.	Chenaqua L.	Chippewa Fl.	Clear L.	Dells Pd.	Ellison L.	Fairchild Pd.	Granite L.	Horse L.	Little Bear Cr.
Examined 110	4	10	1	10	1	7	3	11	1	4
Infected 108	4	10	1	10	1	7	3	11	1	2
Bothriocephalus claviceps	...	...	...	1^{1}	...	3^{1}	1^{1}	...	...	...
Camallanus oxycephalus	...	...	...	1^{1}	...	3^{1}	...	2^{1}	...	...
***Camallanus oxycephalus*	...	2^{1}	1^{1}	1^{1}	...	2^{1}	...	...	1^{1}	1^{1}
Capillaria catenata	...	...	...	1^{1}	...	...	...	6^{1}	...	...
**Clinostomum marginatum*	4^{1}	...	1^{1}	2^{1}	1^{1}	2^{1}	...	10^{1}	...	...
***Contracaecum* sp.	2^{1}	...	...	...	...	...	...	3^{1}	...	...
	1^{2}									
Crepidostomum cooperi	...	...	...	...	...	...	...	4^{1}	...	...
***Crepidostomum cooperi*	...	...	...	...	1^{1}	...	...	...	...	...
Crepidostomum cornutum	...	...	...	...	...	...	...	...	...	1^{1}
	1^{2}									
**Diplostomulum scheuringi*	2^{1}	...	...	1^{1}	...	2^{1}	...	8^{1}	1^{1}	...
Gyrodactyloidea	...	2^{1}	...	8^{1}	...	4^{1}	1^{1}	...	1^{1}	...
	4^{2}	8^{2}	2^{2}	1^{2}	1^{2}	2^{2}	2^{2}	4^{2}		
						1^{3}		7^{3}		
Leptorhynchoides thecatus	...	...	...	3^{1}	...	...	...	2^{1}	...	...
Myxosporidia	...	...	...	2^{2}	...	...	...	...	...	...
**Neascus* sp.	...	...	...	1^{1}	...	5^{1}	2^{1}	...	1^{1}	1^{1}
				1^{2}		2^{2}	1^{2}	9^{2}		
	4^{3}			8^{3}	1^{3}			2^{3}		
**Posthodiplostomum minimum*	...	...	...	3^{1}	...	...	...	...	...	...
			1^{2}	4^{2}		6^{2}	2^{2}	8^{2}		
	4^{3}				1^{3}		1^{3}	3^{3}	1^{3}	
**Proteocephalus ambloplitis*	...	3^{1}	...	2^{1}	...	2^{1}	...	1^{1}	...	...
Spinitectus carolini	...	...	...	7^{1}	1^{1}	2^{1}	1^{1}	...	...	...
Spinitectus gracilis	...	...	...	...	...	...	2^{1}	...	...	...
							1^{2}			
**Spiroxys* sp.	...	...	...	...	...	...	...	1^{1}	...	...
**Triaenophorus nodulosus*	...	...	1^{1}	...	...	...	...	...	...	...

TABLE 19—*(Continued)*

Lepomis gibbosus (Linn.)—PUMPKINSEED

	Little Clam L.	Little Long L.	Long L. (1)	Long L. (2)	Long L. (W)	Mondeaux Fl.	Mud Hen L.	Sauntry's Pocket	Simms L.	Siskowitt L.
	10	10	4	10	1	11	1	4	2	5
	10	10	4	10	1	11	1	4	2	5
Bothriocephalus claviceps	....	....	....	1^{1}	....	3^{1}	....	....	1^{1}	....
Camallanus oxycephalus	1^{1}	....	....	....	....	....	....	....	....	....
***Camallanus oxycephalus*	4^{1}	....	....	....	....	1^{1}	....	....	....	....
**Clinostomum marginatum*	1^{1}	2^{1}	1^{1}	....	1^{1}	9^{1}	....	....	1^{1}	....
***Contracaecum* sp.	....	....	....	....	....	....	....	3^{1}	....	....
**Contracaecum* sp.	....	....	....	....	1^{1}	....	....	....	....	....
Crepidostomum cooperi	....	5^{1}	....	....	1^{1}	....	....	2^{1}	....	2^{1}
										3^{2}
***Crepidostomum cooperi*	....	....	1^{1}	....	....	....	....	1^{1}	....	....
								1^{2}		
Crepidostomum cornutum	4^{1}	....	....	....	....	....	....	....	....	....
	5^{2}									
⊥*Crepidostomum cornutum*	1^{1}	....	....	....	....	....	....	....	....	....
Dichelyne cotylophora	3^{1}	....	....	....	....	....	....	....	....	....
**Diplostomulum scheuringi*	4^{1}	....	....	....	....	....	1^{1}	2^{1}	1^{1}	4^{1}
									1^{2}	
Gyrodactyloidea	9^{1}	1^{1}	....	9^{1}	1^{1}	8^{1}	1^{1}	2^{1}	....	2^{1}
	1^{2}	8^{2}	4^{2}	1^{2}		2^{2}		1^{2}		3^{2}
		1^{3}							2^{3}	
Leptorhynchoides thecatus	....	....	....	....	....	....	1^{1}	....	1^{1}	....
**Leptorhynchoides thecatus*	....	....	....	....	1^{1}	....	....	....	1^{1}	....
**Neascus* sp.	4^{1}	....	....	....	....	7^{1}	....	1^{1}	....	2^{1}
	1^{2}	6^{2}				3^{2}	1^{2}	2^{2}	1^{2}	2^{2}
	1^{3}	4^{3}	4^{3}		1^{3}			1^{3}	1^{3}	1^{3}
Neoechinorhynchus cylindratus	....	....	....	....	....	1^{1}	....	....	....	....
**Neoechinorhynchus* sp.	....	....	....	....	....	1^{1}	....	....	....	....
Pomphorhynchus bulbocolli	....	....	1^{1}	....	....	....	....	....	....	....
**Posthodiplostomum minimum*	4^{1}	2^{1}	....	....	....	....	....	1^{1}	....	....
	1^{2}	4^{2}				5^{2}		2^{2}		
		3^{3}			1^{3}	2^{3}	1^{3}	1^{3}	1^{3}	
**Proteocephalus ambloplitis*	....	....	....	....	....	1^{1}	....	....	....	....
***Proteocephalus pearsei*	....	....	....	....	....	....	....	1^{1}	....	....
***Proteocephalus* sp.	....	....	....	....	1^{1}	....	....	....	....	....
**Proteocephalus* sp.	....	....	....	....	....	....	....	1^{1}	....	....
Spinitectus carolini	3^{1}	1^{1}	....	....	1^{1}	....	1^{1}	....	....	....
									2^{2}	
Spinitectus gracilis	....	....	3^{1}	....	....	....	....	....	....	3^{1}
**Spiroxys* sp.	1^{1}	....	....	....	1^{1}	....	....	....	....	....
**Tetracotyle* sp.	....	....	....	....	....	....	....	1^{1}	....	....

TABLE 20

Lepomis m. macrochirus Raf.—COMMON BLUEGILL

	ASHEGON L.	BEAVER DAM L.	CHENAQUA L.	CHIPPEWA FL.	CLEAR L.	DELLS PD.	EAST TWIN L.	ELLISON L.	FAIRCHILD PD.	GRANITE L.	HALF MOON L.	HAY CREEK PD.	LITTLE BEAR CR.
Examined 220	3	10	10	1	11	11	3	8	11	12	13	12	5
Infected 206	3	10	9	1	11	11	3	8	11	12	13	12	5
Achtheres micropteri	1^{1}												
Bothriocephalus claviceps						1^{1}			5^{1}			3^{1}	
Camallanus oxycephalus								3^{1}	5^{1}				
⊥*Camallanus oxycephalus*					3^{1}								
					1^{2}								
***Camallanus oxycephalus*					3^{1}								
Capillaria catenata					5^{1}					4^{1}			
**Clinostomum marginatum*	1^{1}	1^{1}											
***Contracaecum* sp.		1^{1}											
Crepidostomum cooperi								1^{1}		1^{1}			
⊥*Crepidostomum cooperi*										1^{1}			
***Crepidostomum cooperi*						8^{1}				2^{1}			
						1^{2}							
Crepidostomum cornutum		1^{1}							2^{1}				
	1^{2}												
**Diplostomulum scheuringi*		3^{1}			3^{1}			5^{1}	1^{1}	2^{1}		1^{1}	
Ergasilus caeruleus		1^{1}							1^{1}				
*Glochidia		3^{1}		1^{1}									
Gyrodactyloidea	1^{1}		4^{1}		2^{1}		1^{1}	3^{1}	3^{1}	1^{1}	7^{1}	12^{1}	4^{1}
		6^{2}	3^{2}	1^{2}	4^{2}	10^{2}	1^{2}	4^{2}	7^{2}	6^{2}	4^{2}		
		4^{3}			3^{3}	1^{3}		1^{3}		5^{3}			
Leptorhynchoides thecatus		4^{1}			1^{1}					10^{1}	12^{1}		
											1^{2}		

TABLE 20—(*Continued*)

Lepomis m. macrochirus Raf.—COMMON BLUEGILL

	ASHEGON L.	BEAVER DAM L.	CHENAQUA L.	CHIPPEWA FL.	CLEAR L.	DELLS PD.	EAST TWIN L.	ELLISON L.	FAIRCHILD PD.	GRANITE L.	HALF MOON L.	HAY CREEK PD.	LITTLE BEAR CR.
Examined 220 Infected 206	3 3	10 10	10 9	1 1	11 11	11 11	3 3	8 8	11 11	12 12	13 13	12 12	5 5
**Neascus* sp.	1^1 2^2	4^1 6^2	......	......	7^1 4^2	...... 8^2 3^3	......	7^1	1^1 8^2 2^2	6^1 6^2	6^1 2^2	3^1	3^1
Neoechinorhynchus cylindratus	......	......	......	......	......	......	......	......	......	......	1^1	1^1	......
**Posthodiplostomum minimum*	...... 3^3	...... 10^3	......	...... 1^2	...... 11^2	...... 11^2	......	2^1 5^2	...... 2^2 9^3	1^1 9^2 2^3	...... 13^2	......	......
**Proteocephalus ambloplitis*	......	......	......	......	4^1 5^2	......	1^1	5^1	......	4^1	......	......	......
***Proteocephalus* sp.	......	......	......	......	......	......	......	2^1	......	......	1^1	......	......
Spinitectus carolini	1^1 2^2	9^1	5^1	......	10^1 1^2	7^1 1^2	......	3^1	6^1 3^2	8^1 1^2	11^1	12^1	......
Spinitectus gracilis	1^1	......	......	......	......	......	......	......	5^1 6^2	......	......	......	......

TABLE 20—*(Continued)*

Lepomis m. macrochirus Raf.—COMMON BLUEGILL

	LITTLE CLAM L.	LITTLE GRANITE L.	LONG L. (1)	LONG L. (2)	LONG L. (W)	MONDEAUX FL.	MOOSE L.	MUD HEN L.	PELICAN L.	SIMMS L.	UPPER CLAM L.	WAPOGASSET CR.	WEST TWIN L.
	10 9	12 12	9 9	12 12	12 12	10 10	1 1	11 11	12 0	5 5	4 4	6 6	6 6
Bothriocephalus claviceps										3^1			
Camallanus oxycephalus												1^1	
⊥*Camallanus oxycephalus*		1^1											
***Camallanus oxycephalus*	5^1	1^1										4^1	
												1^2	
Capillaria catenata		1^1											
**Clinostomum marginatum*						2^1							1^1
***Crepidostomum cooperi*			4^1										
			5^2										
Crepidostomum cornutum					5^1								
**Diplostomulum scheuringi*	6^1							7^1		2^1			2^1
**Diplostomulum* sp.												6^1	
Ergasilus caeruleus					2^1			2^1					
*Glochidia					6^1								
Gyrodactyloidea	7^1	6^1	7^1		6^1	9^1	1^1	5^1		1^1	1^1	2^1	1^1
	1^2	6^2	2^2	4^2	6^2	1^2		2^2		3^2			4^2
	1^3			8^3						1^3			
Leptorhynchoides thecatus					8^1			8^1		4^1			
										1^2			
**Leptorhynchoides thecatus*												2^1	
**Neascus* sp.		8^1	9^1		2^1	7^1		3^1		1^1	1^1	2^1	3^1
		3^2			10^2			7^2		4^2	2^2		
	1^3	1^3						1^3			1^3		

TABLE 20—*(Continued)*

Lepomis m. macrochirus Raf.—COMMON BLUEGILL

	LITTLE CLAM L.	LITTLE GRANITE L.	LONG L. (1)	LONG L. (2)	LONG L. (W)	MONDEAUX FL.	MOOSE L.	MUD HEN L.	PELICAN L.	SIMMS L.	UPPER CLAM L.	WAPOGASSET CR.	WEST TWIN L.
	10 9	12 12	9 9	12 12	12 12	10 10	1 1	11 11	12 0	5 5	4 4	6 6	6 6
Neoechinorhynchus cylindratus							1^{1}						
Pomphorhynchus bulbocolli							1^{1}						
**Posthodiplostomum minimum*					1^{1}	2^{1}					2^{1}		
					11^{2}	7^{2}		5^{2}		1^{2}	2^{2}		
							1^{3}		6^{3}				4^{3}
**Proteocephalus ambloplitis*		9^{1}	3^{1}	1^{1}		4^{1}				2^{1}		1^{1}	4^{1}
		3^{2}								3^{2}			1^{2}
***Proteocephalus pearsei*					1^{1}								
Spinitectus carolini	8^{1}	5^{1}				3^{1}		6^{1}		4^{1}	1^{1}		4^{1}
					12^{2}					1^{2}			
Spinitectus gracilis			6^{1}				1^{1}	3^{1}			2^{1}		
			3^{2}										
**Spiroxys* sp.													1^{1}

TABLE 21

Ambloplites r. rupestris (Raf.)—Northern rock bass

	Beaver Dam L.	Big Falls Fl.	Chippewa Fl.	Knuteson Cr.	Ladysmith Fl.	Little Bear Cr.	Long L. (1)	Long L. (W)	Moose L.	Mud Hen L.	Upper Clam L.	Wapogassett Cr.	White Bass L.
Examined 72	7	4	3	5	8	3	7	4	10	7	5	2	7
Infected 70	7	4	3	3	8	3	7	4	10	7	5	2	7
***Bothriocephalus cuspidatus*	2^{1}	......	......	......	......	......	......	......	......	......	......	......	......
Camallanus oxycephalus	1^{1}	1^{1}	1^{1}	......	2^{1}	......	......	......	......	......	......	......	......
⊥*Camallanus oxycephalus*	2^{1}	......	......	......	......	......	......	......	2^{1}	......	......	......	3^{1}
									3^{2}				
***Camallanus oxycephalus*	2^{1}	......	......	......	......	......	......	......	4^{1}	......	......	1^{1}	1^{1}
			1^{2}									1^{2}	
Capillaria catenata	......	......	......	......	......	......	......	......	......	7^{1}	......	......	......
**Clinostomum marginatum*	......	......	......	......	......	......	......	......	......	1^{1}	......	......	......
***Contracaecum brachyurum*	......	......	......	......	......	1^{1}	......	1^{1}	......	......	......	......	......
Crepidostomum cooperi	......	......	......	......	......	2^{1}	......	......	......	......	......	......	......
⊥*Crepidostomum cooperi*	......	......	......	......	......	......	......	......	1^{1}	......	......	......	......
***Crepidostomum cooperi*	......	......	......	......	......	......	......	......	2^{1}	......	......	......	......
Crepidostomum cornutum	......	......	......	......	1^{1}	......	......	......	......	......	......	......	......
Cryptogonimus chyli	......	......	......	......	......	......	......	......	......	......	......	1^{1}	......
										4^{2}			
								1^{3}		3^{3}			
⊥*Cryptogonimus chyli*	......	......	......	......	......	1^{2}	......	2^{2}	......	......	......	......	......
								1^{3}					
***Cryptogonimus chyli*	......	......	......	......	......	......	......	......	......	......	......	1^{1}	......
**Diplostomulum scheuringi*	2^{1}	1^{1}	1^{1}	......	......	......	......	1^{1}	2^{1}	6^{1}	......	1^{1}	2^{1}
	4^{2}							3^{2}		1^{2}			
	1^{3}												
Ergasilus caeruleus	3^{1}	......	2^{1}	......	......	......	......	......	2^{1}	3^{1}	......	......	......
	4^{2}							2^{2}	5^{2}				
			1^{3}					1^{3}	1^{3}				

TABLE 21—(Continued)

Amblopites r. rupestris (Raf.)—NORTHERN ROCK BASS

	Beaver Dam L.	Big Falls Fl.	Chippewa Fl.	Knuteson Cr.	Ladysmith Fl.	Little Bear Cr.	Long L. (1)	Long L. (W)	Moose L.	Mud Hen L.	Upper Clam L.	Wapogassett Cr.	White Bass L.
*Glochidia								2^{1}					
Gyrodactyloidea	4^{1}	1^{1} 2^{2}	1^{1} 1^{2}	1^{1}	5^{1} 3^{2}	2^{1}		2^{2} 2^{3}		6^{1} 1^{2}	4^{1}		2^{1}
Illinobdella moorei						2^{1}							
Leptorhynchoides thecatus	4^{1} 1^{2}			1^{1}				3^{1} 1^{2}	5^{1}	6^{1} 1^{2}	2^{1}		6^{1} 1^{2}
**Neascus* sp.	7^{2}	4^{1}	1^{1}			1^{1} 1^{2}	5^{2} 2^{3}	1^{2} 3^{3}	4^{1}	7^{3}	2^{2} 3^{3}	2^{1}	4^{2} 3^{3}
Neoechinorhynchus cylindratus	2^{1}		1^{1}				1^{1}		5^{1}		1^{1}		3^{1}
Pomphorhynchus bulbocolli				2^{1}									
**Posthodiplostomum minimum*	1^{2} 6^{3}		2^{2} 1^{3}			1^{1} 2^{2}		1^{2} 3^{3}	3^{1} 5^{2}	4^{1} 2^{2} 1^{3}		2^{2}	
**Proteocephalus ambloplitis*								1^{1}					
***Proteocephalus pearsei*	3^{1}							1^{1}					
**Proteocephalus* sp.				1^{1}									
***Proteocephalus stizostethi*								1^{1}					
Spinitectus carolini								4^{1}					
Spinitectus gracilis		3^{1} 1^{2}			7^{2} 1^{3}		4^{1} 2^{2}		6^{1} 3^{2}		5^{1}		

TABLE 22

Pomoxis nigro-maculatus (Le Sueur)—BLACK CRAPPIE

	BEAVER DAM L.	BIG FALLS FL.	CHENAQUA L.	CHIPPEWA FL.	CLEAR L.	DELLS PD.	ELLISON L.	FAIRCHILD PD.	GRANITE L.	HALF MOON L.	HAY CREEK PD.	HORSE L.	LADYSMITH FL.
Examined 229 Infected 205	12 12	9 9	8 3	13 13	10 10	13 13	11 11	12 12	6 6	10 10	12 5	1 1	11 11
Camallanus oxycephalus	2^1	.....	.....	1^1	1^1	1^1	9^2	2^1	3^1 1^2 1^1	5^1	.....	.....	4^1
⊥*Camallanus oxycephalus*	2^1	1^1	.....	3^1	.....	.....	2^2	4^1		.....	.....	.....	.....
***Camallanus oxycephalus*	7^1	3^1	2^1	4^1	.....	.....	.....	5^1	.....	2^1	.....	1^1	2^1
**Contracaecum* sp.	.....	.....	.....	.....	.....	.....	.....	1^1	.....	.....	.....	.....	.....
***Crepidostomum* sp.	1^1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
**Diplostomulum scheuringi*	7^1 1^2	.....	.....	.....	3^1	.....	9^1	.....	1^1	.....	1^1	1^1	.....
Ergasilus caeruleus	.....	.....	.....	.....	.....	.....	.....	4^1 1^2	.....	.....	.....	.....	.....
Gyrodactyloidea	3^1	8^1	.....	6^1 7^2	10^1	3^1	6^1 5^2	3^1 6^2	3^1 3^2	8^1	.....	.....	8^1
Leptorhynchoides thecatus	3^1	.....	.....	.....	.....	.....	.....	.....	4^1	3^1	.....	1^1	1^1
**Leptorhynchoides thecatus*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1^1	.....
Myxosporidia	.....	3^1	.....	1^1	1^2	.....	3^1 1^2 1^3	.....	1^2	.....	.....	.....	1^1
**Neascus* sp.	.....	.....	.....	.....	1^1	11^1 2^2	.....	1^1	.....	.....	.....	.....	.....
Neoechinorhynchus cylindratus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3^1
***Proteocephalus pearsei*	1^1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Spinitectus carolini	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4^1	.....	5^1 4^2 1^3
Spinitectus gracilis	.....	7^1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
**Spiroxys* sp.	1^1	.....	1^1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 22—(*Continued*)

Pomoxis nigro-maculatus (Le Sueur)—Black crappie

	Little Clam L.	Little Granite L.	Long L. (W)	Lower Clam L.	Mondeaux Fl.	Moose L.	Mud Hen L.	Pelican L.	St. Croix L.	Siskowitt L.	Somers Cr.	Upper Clam L.
	10	12	9	5	10	13	10	3	10	8	1	10
	10	5	9	5	10	13	10	0	10	6	1	10
Camallanus oxycephalus	...	...	...	1[1]	...	1[1]	...	...	...	...	1[1]	2[1]
⊥*Camallanus oxycephalus*	1[1]	...	...	...	...	1[1] 5[2]	...	...	...	...	...	...
***Camallanus oxycephalus*	6[1]	...	...	...	8[1] 1[2]	6[1]	2[1]	...	...	...	...	2[1]
**Diplostomulum scheuringi*	8[1]	...	5[1] 2[1] 1[2]	...	1[1]	...	9[1]	...	...	...	...	...
*Glochidia	...	...		...	...	...	...	...	...	...	...	...
Gyrodactyloidea	...	5[1]	9[1]	4[1]	...	1[2] 11[1] 2[2]	10[1]	...	7[1]	...	...	4[1]
Leptorhynchoides thecatus	...	...	9[1]	1[1]	...	1[1]	...	...	2[1]	...	...	...
**Neascus* sp.	...	...	4[1] 4[2]	...	...	...	...	...	4[1]	...	...	10[1]
Neoechinorhynchus cylindratus	...	...	...	1[2] 1[1]	...	...	...	...	...	...	...	3[1]
***Proteocephalus stizostethi*	...	...	...	1[1]	...	...	...	...	...	...	...	...
Spinitectus gracilis	2[1]	...	...	4[1]	...	1[1]	...	...	6[1] 1[2]	6[1]	...	7[1]

CHECK LIST OF PARASITES

TREMATODA

Parasite	*No. spp. fish infected*
Allocreadium ictaluri Pearse, 1924	1
Allocreadium lobatum Wallin, 1909	5
Allocreadium sp.	1
Alloglossidium corti (Lamont, 1921)	3
Alloglossidium geminus (Mueller, 1930)	1
Azygia augusticauda (Stafford, 1904)	7
Bucephalopsis pusilla (Stafford, 1904)	1
Bunodera sacculata Van Cleave and Mueller, 1932	2
Bunoderina eucaliae Miller, 1938	2
Caecincola parvulus Marshall and Gilbert, 1905	2
Clinostomum marginatum (Rudolphi, 1819)	10
Crepidostomum cooperi Hopkins, 1931	6
Crepidostomum cornutum Osborn, 1903	6
Crepidostomum farionis (Mueller, 1788)	1
Crepidostomum isostomum Hopkins, 1931	2
Crepidostomum lintoni (Pratt in Linton, 1901)	1
Crepidostomum sp.	1
Cryptogonimus chyli Osborn, 1903	1
Diplostomulum scheuringi Hughes, 1929	10
Diplostomulum spp.	21
Gyrodactyloidea	19
Macroderoides flavus Van Cleave and Mueller, 1932	1
Macroderoides parvus (Hunter, 1932)	1
Neascus spp.	30
Phyllodistomum brevicecum Steen, 1938	1
Phyllodistomum etheostomae Fischthal, 1942	1
Phyllodistomum lysteri Miller, 1940	1
Phyllodistomum sp.	1
Phyllodistomum staffordi Pearse, 1924	2
Plagiocirrus primus Van Cleave and Mueller, 1932	1
Posthodiplostomum minimum (Mac Callum, 1921)	13
Rhipidocotyle papillosum (Woodhead, 1929)	1
Sanguinicola occidentalis Van Cleave and Mueller, 1932	1
Tetracotyle spp.	6
Trematoda—larval	1
Triganodistomum attenuatum Mueller and Van Cleave, 1932	2

CESTODA

Abothrium crassum (Bloch, 1779)	1
Bothriocephalus claviceps (Goeze, 1782)	2
Bothriocephalus cuspidatus Cooper, 1917	4
Bothriocephalus formosus Mueller and Van Cleave, 1932	1
Bothriocephalus sp.	3
Caryophyllaeidae	1
Corallobothrium fimbriatum Essex, 1927	1
Corallobothrium giganteum Essex, 1927	1
Glaridacris catostomi Cooper, 1920	2
Glaridacris confusus Hunter, 1929	2
Haplobothrium globuliforme Cooper, 1914	1
Ligula intestinalis (Linnaeus, 1758)	2
Pliovitellaria wisconsinensis Fischthal, 1951	2
Proteocephalus ambloplitis (Leidy, 1887)	11
Proteocephalus fluviatilis Bangham, 1925	2
Proteocephalus pearsei La Rue, 1919	5

Parasite	*No. spp. fish infected*
Proteocephalus pinguis La Rue, 1911	2
Proteocephalus spp.	9
Proteocephalus stizostethi Hunter and Bangham, 1933	5
Triaenophorus nodulosus (Pallas, 1781)	4
Triaenophorus stizostedionis Miller, 1945	2
NEMATODA	
Camallanus oxycephalus Ward and Magath, 1917	14
Capillaria catenata Van Cleave and Mueller, 1932	3
Contracaecum brachyurum (Ward and Magath, 1917)	4
Contracaecum spp.	17
Cucullanus sp.	1
Cystidicola stigmatura (Leidy, 1886)	1
Dichelyne cotylophora (Ward and Magath, 1917)	4
Dichelyne robusta (Van Cleave and Mueller, 1932)	2
Hepaticola bakeri Mueller and Van Cleave, 1932	1
Philometra sp.	1
Rhabdochona cascadilla Wigdor, 1918	7
Rhabdochona sp.	1
Spinitectus carolini Holl, 1928	11
Spinitectus gracilis Ward and Magath, 1917	11
Spiroxys sp.	10
ACANTHOCEPHALA	
Leptorhynchoides thecatus (Linton, 1891)	20
Neoechinorhynchus crassus Van Cleave, 1919	4
Neoechinorhynchus cylindratus (Van Cleave, 1913)	7
Neoechinorhynchus rutili (Mueller, 1780)	3
Neoechinorhynchus saginatus Van Cleave and Bangham, 1949	1
Neoechinorhynchus sp.	2
Neoechinorhynchus tenellus (Van Cleave, 1913)	2
Pomphorhynchus bulbocolli Linkins, 1919	11
PROTOZOA	
Myxosporidia	14
Trichodina sp.	3
COPEPODA	
Achtheres micropteri Wright, 1882	2
Argulus versicolor Wilson, 1902	1
Ergasilus caeruleus Wilson, 1911	5
Ergasilus sp.	1
MOLLUSCA	
Glochidia	14
HIRUDINEA	
Illinobdella moorei Meyer, 1940	1
Illinobdella sp.	3
VIRUS	
Lymphocystis	1

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ADMIRAL RUSSELL AND THE MEDITERRANEAN CAMPAIGN OF 1694–1695*

ROBERT H. IRRMANN
Associate Professor of History, Beloit College

It is related that in the reign of Charles II, an act of Parliament was prefaced with the comforting observation that upon the Navy, "under the good providence of God, the wealth, safety, and strength of the kingdom chiefly depend." In the 1690's, William III and the Protestant Succession were to witness the truth of this on at least three dramatic occasions: the defeat of the French invasion fleet at La Hogue in 1692; the frustration of the attempted Jacobite-French invasion of England in 1696; and the remarkable eighteen-month sojourn of the Royal Navy in the Mediterranean in 1694–1695. The hand at the helm for England in each of the aforementioned instances was that of Edward Russell, Admiral of the Fleet. In this inspeximus, not to the grand sweep of the Pepysian or Williamite navies shall we turn, but rather to the fleet under Russell's command.

The "abdication" of James II in 1688 brought in the Protestant Succession of William of Orange and Mary. French gold, troops and ships were put at James' disposal time and again in the '90's, to enable James to attempt the recovery of his throne. The attempt to capture Ireland, the "backdoor" to England, was frustrated at the Battle of Boyne Water on July 1, 1690. Two years later Edward Russell broke for the moment the power of France upon the sea at the running battle of Barfleur and La Hogue of May, 1692. Indecision and contradictory schemes kept the English Admiralty from pursuing their gains to complete and ultimate victory in the Channel and along the Atlantic coast, and England failed to reap the fullest benefits from her initial successes at sea.

Rivalry in naval administration had confounded operations in the summer of 1692; rivalry drove Russell from office, and he relinquished command of the fleet to the triumvirate of Admirals Killigrew, Delaval and Shovel in January of 1693. This is not what some had thought would happen, but "Admiral Russell has declined going to sea next summer if he must receive orders

* The material of this paper is a brief condensation of a general study (unpublished) of the campaign and career of Admiral Russell in the Mediterranean in the years 1694–1695. The author's intention here has been to sketch in general terms the progress of that expedition, and briefly note the results, rather than to trace in great detail the week by week development of that campaign.

through Lord Nottingham's hands (Secretary of State, and Russell's deadly Parliamentary and administrative rival)."[1] King William felt, at the moment, more need of Nottingham's services than of Russell's; since they could not work together, one had to be sacrificed. Russell was out of office in 1693.[2] The work of the Navy continued, nonetheless, for the War of the League of Augsburg, or, for England, the War for the Protestant Succession, against Louis XIV went on. The campaign at sea in 1693 was projected for annoyance of the enemy and protection of English trade. It did neither effectively. Misfortune dogged the heels of the naval command. Seamen were so scarce that it was May before the fleet was put out.[3] In June the Smyrna Convoy under Admiral Rooke was set upon by a superior French force, and over one hundred merchantmen were lost at Lagos Bay.[4]

The disaster lay not so much with Rooke or with the Admiralty's faulty information, as with confusion of orders and general misdirection of available information.[5] The conduct of affairs at sea in 1693 showed that this joint-admiral-commission had not been a very workable arrangement, and public displeasure was soon to fall upon the Tory ministry. In the spring of 1694 the Whigs were to be put into office. As Nottingham put it:

> . . . the king finding his affairs abroad improsperous, the French victorious, and a necessity of increasing his army and consequently of raising greater sums of money from the nation . . . unaccustomed to such heavy burdens and un-

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[1] N. Luttrell, *A Brief Historical Relation of State Affairs from September 1678 to April 1712* (6 volumes, Oxford, 1867), III (January 23, 1692), p. 18; John Evelyn, *Diary,* edited by H. B. Wheatley (London, 1906), III, 107; Rapin de Thoyras, *The History of England . . . Translated into English with additional notes (and a continuation to the accession of George II) by N. Tindal* (5 volumes, London, 1743–7), III, 236–7; W. A. Aiken, *The Conduct of the Earl of Nottingham* (New Haven, 1941), p. 116. See also, *Correspondence of the family of Hatton . . . 1601–1704,* edited by E. M. Thompson (2 volumes, Camden Society, 1878), II, 188.

[2] K. Feiling, *History of the Tory Party,* 1640–1714 (Oxford, 1924), p. 295. John Ehrman, in his recent article on "William III and the Emergence of a Mediterranean Naval Policy, 1692–4" states that the major result of the Barfleur campaign was to secure the dismissal of Russell as commander-in-chief of the fleet and Nottingham as Secretary of State in charge of naval affairs, but he has not clearly indicated the chronology of the events. Almost a year intervened between the dismissal of Russell and the subsequent dismissal of Nottingham. *The Cambridge Historical Journal* (Cambridge, 1949), IX, #3, p. 269.

[3] J. Burchett, *A Complete History of the Most Remarkable Transactions at Sea . . .* (to 1712) (London, 1720), p. 480; T. Lediard, *The Naval History of England . . . to the Conclusion of 1734* (2 volumes, London, 1735), II, 673; *London Gazette,* No. 2856. Killigrew and Delaval were put on the Admiralty Board, and given command of the Channel fleet.

[4] C. de la Ronciere, *Histoire de la Marine Française,* VI (Paris, 1932), pp. 139–146; L. Guerin, *Histoire Maritime de France* (2 volumes, Paris, 1844), II, 78; letter from Captain Littleton, of the *Smyrna–Factor,* quoted by Tindal, *Continuation,* III, 242–4, and note #1, pp. 243–4; Burchett, *op. cit.*, pp. 484–8; *Nottingham's Conduct,* pp. 116, 117–20. Ehrman notes the monetary loss as amounting to £1,000,000. *Cambridge Historical Journal,* IX, #3, p. 277.

[5] *House of Lords Manuscripts, 1693–5* (Historical Manuscripts Commission, 1900), I, 176–7; Tindal, *Continuation,* III, 248–9, and note #2, and p. 249, note #1.

easy under them, and the Whigs promising to extricate him out of all his difficulties if he would put his affairs into their hands, he yielded to their importunity.[6]

In November of 1693 Russell was made Admiral of the Fleet. Nottingham relinquished the seals of the Secretary of State on November 6, and the Earl of Shrewsbury assumed the vacant office. Russell was appointed First Lord of the Admiralty on April 26, 1694.[7] William observed that at the moment the cabinet was "composed better than formerly and (of) persons who could at least draw together in . . . business."[8]

The essence of the quarrel between Russell and Nottingham hinged on the failure of the triumvirate in command of the fleet in 1693, for Russell had washed his hands of the whole affair by refusing the command after the campaign ended in 1692, and Nottingham had acquiesced in the appointment of Killigrew, Delaval and Shovel.[9] With the failure of the triumvirate, Russell alone remained as the most capable man to command in the coming season. But the bitterness produced by the aftermath of the Barfleur campaign remained, and either Nottingham had to go out, and permit Russell to take up the command, or an inferior had to be sought. At this juncture, naval policy seemed of greater importance to the King, and William dismissed Nottingham.[10]

Naval action had meanwhile continued desultorily against the French. Admiral Benbow had worked little damage in the Channel, and Francis Wheler had achieved scant success in the West Indies. The latter commander arrived in England in mid-October of 1693, in time to carry out an assignment consequent upon the French victory over the Smyrna fleet. Following their triumph of June, 1693, at Lagos Bay, Admirals Tourville and d'Estrees retired to Toulon, with the largest French fleet ever seen in the Mediterranean: ninety-three ships of the line, and

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[6] *Nottingham's Conduct*, p. 134.

[7] R. Lodge, *The History of England, from the Restoration to the death of William III* (1660–1702) (London, 1910), *The Political History of England* series, Volume VIII, pp. 384–7; Sir Edward Harley to Abigail Harley, November 7, 1693, *Portland Manuscripts* (Historical Manuscripts Commission, 1894–1907), p. 547; Tindal, *Continuation*, III, 252–3; *Nottingham's Conduct*, p. 123; Feiling, *op. cit.*, p. 296. Nottingham was dismissed from office on Monday, November 6, 1693, but Shrewsbury did not take office until March, 1694. The warrant for Shrewsbury's Dukedom was drawn on April 25, 1694. *Calendar of State Papers, Domestic Series, 1694–5*, p. 116. These will hereinafter be referred to as CSPD.

[8] CSPD, *1694–5*, p. 192. See also Ehrman, *Cambridge Historical Journal*, IX, #3, p. 282.

[9] *Nottingham's Conduct*, pp. 130–31.

[10] *Ibid.*, p. 123. As Ehrman remarks in his "William III and the Emergence of a Mediterranean Naval Policy, 1692–4", neither Secretary of State was officially responsible for naval affairs, but Nottingham had in effect been managing them since 1689. His removal from their unofficial charge was effected by transferring them to his recently appointed colleague and enemy, Sir John Trenchard. *Cambridge Historical Journal*, IX, #3, p. 269, note #3.

sixty lower rates.[11] Wheler was assigned to the Straits, and left England in late November. After convoying the returning Spanish Plate Fleet safely to port, he attempted to pass the Straits of Gibraltar and enter the Mediterranean. A violent storm sank six English ships on February 18–19, 1694, and Wheler perished, along with five other officers. In all, some eight hundred and twenty-four men were lost.[12] France was momentarily supreme in the Mediterranean; Spain, England's ally, was severely threatened, and to ensure her continuance in the war against Louis XIV, William had to make a new move. His decision involved the services of Edward Russell, and resulted in the inauguration of a new feature of English naval policy.

The momentary massing of French naval strength in the harbor of Toulon in the late summer of 1693 had loomed as a threat to British policy. That William III had no fully formulated concept of future Mediterranean policy at the inception of the naval campaign of 1694 seems well substantiated by the facts. Wheler's expedition to the Mediterranean, in conjunction with a Dutch squadron, "was clearly little more than a development of the Cromwellian idea of commerce protection with a powerful cruising squadron."[13] As Admiral of the Fleet, Edward Russell was to direct the main design, which was concerned with activities in the Narrow Sea, and not initially in the Straits. Russell was put to the task of preventing a concentration of the French fleet at Toulon, for d'Estrees and Tourville's original union having been broken, William was anxious to prevent a second occurrence of the same threat. The main fleet under Russell was to surprise and capture Brest before Tourville could get to sea. Then the tables seemed to turn, for it appeared that the Toulon fleet was making for Brest. Wheler was at once ordered to come out of the Mediterranean and wait at Cadiz till the Spanish fleet was ready for sea, or till reinforcements came from England. These orders were soon countermanded, for news of French activity became so alarming that Wheler was ordered home. Before these last orders ever reached him, he had set out to pass the Straits and gain the Mediterranean, and lost his life, and a fair portion of his squadron.[14]

Mediterranean policy had not evolved in its full significance in late March of 1694; this is evident in the orders then given to Russell. Directed to assume command of ninety-three ships, of

[11] De la Ronciere, *op. cit.*, VI, 147–8; Chevalier, *Histoire Marine Française, J'usqu'au traite de paix de 1763*, quoted by Corbett, *England in the Mediterranean* (2 volumes, London, 1904), II, 425.

[12] W. L. Clowes (editor), *The Royal Navy. A History* (London, 1897), II, 362; Burchett, *op. cit.*, pp. 490–4. Burchett places the number lost at 852 in all.

[13] Corbett, *op. cit.*, II, 427

[14] *Ibid.*, II, 427–8.

which forty-six were ships of the line, the Admiral was to "proceed with the Dutch fleet to the westwards, and do his best to harass the enemy without expecting further orders, and to protect the trade passing in and out of the Channel."[15] Then news of Wheler's disaster put a completely different complexion upon affairs! The English squadron in the Straits was forced to return to Cadiz and refit, with no hope of protecting English trade, or preventing the passage of the Brest or Rochefort squadrons through the Straits en route to join at Toulon.[16] The concurrent information that d'Estrees and Tourville had left Paris for their respective commands at Toulon and Brest, and that Marshal de Noailles was about to take the field in Catalonia, made the situation grave indeed.[17] To replace Wheler, Edward Russell was detailed for service in the Mediterranean.[18]

Sir Julian Corbett saw the turning point of Williamite naval policy in the Mediterranean campaign of 1694–1695. Though the victory at La Hogue had given William III command of the sea, it was used in the same old way: coastal raids, attacks on France's channel ports, crippling of privateer activities, "and confusing the strategy of the French armies by diversions."[19] This is true of the campaign of June to August, 1692, and even more true of the fiasco of '93. Corbett dramatized his thesis:

> . . . political and financial difficulties had kept the King so late in England (in 1694) that he found himself deprived of the initiative in Flanders, and his main hope for the year was now centered on what the fleet could do in the Mediterranean. On that he boldly resolved to stake his all, and so with the high resolution that marks the great captains from the small, he penned his memorable order.[20]

In a very broad sense Corbett is justified in his enthusiasm, for Russell's campaign marked the advent of the future permanent English Mediterranean fleet. Russell's sojourn there was a transient instance of that phenomenon; many years were to

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[15] *House of Lords Manuscripts, 1693–5* (Historical Manuscripts Commission, 1900), I, 463.

[16] Corbett, *op. cit.*, II, 429.

[17] *Ibid.*, II, 429; CSPD, *1694–5*, p. 118.

[18] The resolution was laid before the Committee of the Privy Council on April 10, 1694, and agreed to on April 19th. The Instructions were issued on April 24, 1694. Trenchard's notes, quoted by Corbett, *op. cit.*, II, 430, footnote.

[19] Corbett, *op. cit.*, II, 422.

[20] *Ibid.*, II, 433; P. Colomb, *Naval Warfare* (London, 1899), p. 130, merely observes that England went into the Mediterranean to hamper French military activity against Spain. De la Ronciere sees nothing "spectacular" in this move, nor does Clowes. Callender fails to mention the move; Mahan says of it: "the five remaining years of the War of the League of Augsburg (after 1692), in which all Europe was in arms against France, are marked by no great sea battles, nor any single maritime event of the first importance." *The Influence of Sea Power upon History, 1660–1783*, p. 191.

elapse before the stationing of the Mediterranean fleet became continuous. In the immediate order for Russell's proceeding against the French fleet, I doubt if William had anything more in mind than striking a decisive blow. The Instructions to Russell indicate nothing more. They point out that as the disposal of the French fleet for the summer was not as yet known, Russell was to follow one of three courses: 1) to attempt to burn or destroy the French fleet if found at Brest or Belle Isle; 2) to search for it if news were received that the fleet had put to sea, but not to pass south of the latitude of Cape Finisterre; 3) "in case he has trustworthy information that" the fleet "or any part of it has gone to the Mediterranean, or south of Finisterre, to follow and attack it."[21]

Placing the burden of decision upon the commander was well illustrated in these orders (as it was to be throughout Russell's entire command in this campaign) for the Admiral was not to await further orders, but to proceed as he deemed most proper.[22] Time and again the burden of decision was to be put upon Admiral Russell; both Admiralty and Privy Council shunned the assumption of responsibility, with the possibility of Parliamentary chastisement.

Limitations of space prevent me from detailing the course of the Mediterranean expedition of these years. It must suffice to sketch in the broadest strokes the course, and effects, of this campaign, the first such elongated campaign in British naval annals. In early May of 1694 Russell and a portion of his fleet got under sail, but there was still confusion and division of opinion as to the proper course of action: an attack on Brest, or immediate dispatch to the Mediterranean? "I am afraid" Russell wrote, that "these two designs, Brest and the Straits, will hinder one another, and may make neither effectual."[23] He saw the danger in the Mediterranean, and hesitated to waste time, effort and material on the Brest diversion.

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[21] Instructions to Russell, April 24, 1694, *House of Lords Manuscripts, 1693–5*, I, 459; CSPD, *1694–5*, p. 112.

[22] Russell was to report from time to time to Shrewsbury, Secretary of State for the Northern Department, to Sir John Trenchard, who had been sole Secretary following Nottingham's dismissal until Shrewsbury's appointment on March 2, 1694, and to the Admiralty. *House of Lords Manuscripts, 1693–5*, I, 459; CSPD, *1694–5*, p. 112. For the influence of the Secretaries of State in various naval affairs, see M. Thomson, *The Secretaries of State, 1681–1782* (Oxford, 1932), pp. 77–82, 86–89. See also footnote #10, *supra.*

[23] W. Coxe, *Private and Original Correspondence of Charles Talbot, Duke of Shrewsbury* . . . (London, 1821), p. 192; *cf.* Shrewsbury's reply, May 5/15, 1694, *ibid.*, p. 193. See also Privy Council Minutes of May 9 and 14, 1694. *Buccleuch Manuscripts* (Historical Manuscripts Commission, 1903), II, 65–6. Shrewsbury's opinion of the two operations, as expressed to the Council on May 9, was the same as Russell's: "nothing of the Brest preparation should delay the sending the squadron into the Mediterranean, that being, in my opinion, the service that desires preference." *Ibid.*, II, 65–6.

By mid-May King William himself was at last convinced of the prime importance of dominance in the Mediterranean,[24] and he turned to hastening Russell's departure for those waters.[25] The effect was almost instantaneous! Russell ordered Admiral Berkeley to proceed to Brest, and in conjunction with General Talmash to do whatever could be done by land and sea. The Mediterranean voyage was about to begin.[26] On May 29, Russell wrote that "the wind is now fair, and we are going."[27] On June 6th, the squadrons for Brest and the Mediterranean parted company, and Russell proceeded to the Straits with some misgivings. It seemed that the year was too far advanced for effective action, the

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[24] William III to Shrewsbury, May 14, 1694, Coxe, *op. cit.*, p. 32; Shrewsbury to Russell, May 23, 1694, *Buccleuch Manuscripts*, II, 69–70; see also Coxe, same to same, same date, p. 194. For the date of the sailing of the French fleet, see Trenchard to Russell, May 17, 1694, CSPD, *1694–5*, p. 137.

John Ehrman's "William III and the Emergence of a Mediterranean Naval Policy, 1692–4" is an attempt to show that King William held to a conscious Mediterranean policy for England from Barfleur down to Russell's undertaking the expedition in 1694. "On the very morrow of Barfleur, in his first letter to Nottingham after the news had reached the King, Blathwayt wrote that His Majesty wished the inner Council to consider the possibility of sending a squadron to the Mediterranean." (Add. Mss. 37991, f. 87) In August of 1692 "Blathwayt wrote the King was anxious a squadron be sent to the Mediterranean, and requested 'that ships for the purpose be found by any means.'" (Add. Mss. 37991, f. 140—August 14th) As Ehrman further notes, "exactly what William had in mind for the Mediterranean in the late summer of 1692 cannot be said for certain. He revealed his preoccupation with interests other than trade only when trade had failed him, and then he gave no clue to his real intentions. We must infer these largely from his attitude a few months later, when the situation was still much the same but when he himself was more explicit. Undoubtedly one reason for his plan lay in the diplomatic pressure which he hoped to exert upon the Turks, for he referred to this again in 1693;" (Add. Mss. 37992, f. 33) "but it is probable that he also had in mind its effect upon the Spanish Court, which he knew by experience responded to a show of naval force." (S.P. For. 94/73, Stanhope to Nottingham 17 January and 7 March, 1691) Ehrman's conclusion that the Mediterranean policy goes back as far as the days following Barfleur is highly speculative: ". . . if interrupted concentration on one objective is the mark of a policy, then William's conscious Mediterranean policy may be said to date from that time (May, 1692)." *Cambridge Historical Journal*, IX, #3, pp. 273–4.

[25] Coxe, *op. cit.*, p. 39. It was popularly believed for a time that Shovel might be sent to the Mediterranean. Derwentwater's informant gave the definite news of Russell's going thither on June 5, 1694. CSPD, *1695, Addenda* (newsletter), pp. 260–1. See also Shrewsbury to Russell, May 26, 1694, Coxe, *op. cit.*, pp. 196–7.

[26] CSPD, *1694–5*, p. 157; *Buccleuch Manuscripts*, II, 75; *House of Lords Manuscripts*, 1693–5, I, 484–5; Burchett, *op. cit.*, pp. 496–7; *Present State of Europe* (London), June, July, 1694, pp. 204–7, 236–7; C. Sevin, Marquis de Quincy, *Histoire militaire du regne de Louis le Grand* (Paris, 1726), III, 77.

[27] Russell to Trenchard, May 26, 1694, *Buccleuch Manuscripts*, II, 73. Macaulay relates that Russell persisted in claiming ignorance of his destination until he was ready to weigh anchor, and that even Marlborough failed to get the news of the Brest–Mediterranean expedition from him, but got it from other sources, and retailed his information to France. Thus, according to Macaulay, and those who accept his analysis, and the authenticity of the Camaret Bay letter, the French were well prepared for the Brest attack which proved so costly for the English. For the most modern interpretation of the incident, and complete exoneration of Marlborough from any complicity in the disaster, see W. Churchill, *Marlborough, His Life and Times* (New York, 1933), II, chapters VII and VIII. Churchill's arguments against Macaulay's allegations are logical and convincing. See also Luttrell, *op. cit.*, III, 327–8; and Shrewsbury to Bathwayt, June 13, 1694, *Buccleuch Manuscripts*, II, 81.

French too well prepared to meet the English designs.[28] Remarking that he was not a very desponding man, Russell nevertheless confessed to be a little out of hope.[29]

By July 1, the combined Anglo-Dutch fleet stood off Cape Spartel, near the Atlantic entrance to the Straits of Gibraltar. At this juncture word came that the French fleet of seventy sail stood between Alfacques and Barcelona.[30] The imminent danger to Spain had been foreseen by Russell. In coming into the Mediterranean, his aim had been to protect momentarily the Spanish ports between Gibraltar and Barcelona, and eventually to incapacitate or completely destroy the French fleet so that Spain would be menaced no longer.[31] Much ground had been lost in putting Russell's aims into execution, for in May of 1694 Marshal de Noailles had pushed into Catalonia with the French army, supported by Admiral Tourville's fleet off the Catalan coast. On the 17th de Noailles defeated the Spanish army at the Ter River, and the way into Catalonia opened before the French. The Catalan fortresses fell in quick succession. Only the fortress of Ostalric remained between de Noailles and Barcelona, and Tourville was sailing to that latter place to aid in the siege.[32] News of Russell's entrance into the Mediterranean induced de Noailles not to proceed to the siege of Barcelona.[33] Tourville was soon to flee to safer harbor before that advance of the English fleet. By mid-July he had fled to the safety of the Isle of Hieres, and possibly prepared to withdraw to Malta in fear of the English.[34]

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[28] The design on Brest was frustrated by the French, and Talmash killed; the losses for England were very heavy, and seemingly unnecessary. Quincy, *op. cit.*, III, 77–81.

[29] Russell to Trenchard, June 6, 1694, CSPD, *1694–5*, p. 165. *Cf.* same to same, May 29, 1694, *Buccleuch Manuscripts*, II, 73–4.

[30] J. Ehrman: "On July 1, the main allied fleet, with sixty-three men-of-war excluding auxiliaries, entered the Straits *for the first time in English naval history.*" *Cambridge Historical Journal*, IX, #3, p. 285. (Italics mine.)

Russell to Trenchard, July 1, 1694, Coxe, *op. cit.*, pp. 197–8; without the nine Spanish vessels, Russell's combined fleet numbered sixty-three ships of the line. See also Burchett, *op. cit.*, p. 505, and Sourches, *Memoirs du Marquis de Sourches sur le regne de Louis XIV* (Paris, 1885), IV, 349.

[31] Russell to Trenchard, CSPD, *1694–5*, p. 239. Quincy's reflections on the campaign of '94 bear out these conclusions. *Op. cit.*, III, 97–8.

[32] L. von Ranke, *A History of England principally in the Seventeenth Century* (Oxford, 1875), V, 82. Ranke pointed out that "Spain now clearly saw what the (United) Netherlands had long seen; namely, that the great monarchy could no longer defend itself without foreign help. It was of incalculable importance to Spain to be in alliance with the maritime powers." *Ibid.*, V, 82. *Cf.* Quincy, *op. cit.*, III, 55–6. For his success, Louis XIV made de Noailles Vice-roy of Catalonia, which dignity he assumed on July 9, 1694. *Ibid.*, III, 66. See also *Memoires de Noailles* (Paris, 1777), I, 256–7, 265–8; *Present State of Europe*, May–August, 1694, pp. 165, 198–9, 225–9, 264–5.

[33] Sourches, *op. cit.*, entry for June 29, 1694, IV, 349.

[34] The French had promptly retired upon news of the approach of the English—fearful, yet not knowing where the English and Dutch were. Russell to Trenchard, July 13, 1694, CSPD, *1694–5*, p. 224. See also Blathwayt to Shrewsbury, July 9/10, 1694, *Buccleuch Manuscripts*, II, 96; *Present State of Europe*, August 1694, pp. 271–2; Sourches, *op. cit.*, IV, 366.

It is clear that Admiral Russell deeply regretted his inability to meet the French in battle. Even were he to stand before Barcelona, this action would be of little lasting value. The Spaniards, Russell opined, were so weak that the moment the English retired, the French would reappear and take Barcelona, whence they might overrun Catalonia at their pleasure.

After gaining Barcelona, the English fleet would offer to join in any attempt against the French that the Spaniards would propose, and then would prepare to return to England. In Admiral Russell's opinion, the only service the Anglo-Dutch fleet had rendered England in the present campaign was the establishment of a reputation, "which is very great at this time."[35] By July 29 Russell anchored off Barcelona, his fleet in good condition; but the French, he regretted to report, were at Toulon.[36]

It was obvious that the French fleet would continue its refusal to engage until it enjoyed an advantage. In disgust the Admiral announced his intention to remain on the Spanish coast ten days more at the most, and then start homeward.[37] He was in decidedly low spirits over the results of his Mediterranean expedition. In eager expectation he had prepared for the voyage, only to be diverted at the outset by the proposal to make an attempt on Brest. Interpreting his orders in accordance with his own concept of the relative importance of the two objectives, Russell had gone directly to the Mediterranean and put the execution of the Brest diversion upon other shoulders. Seemingly the Mediterranean expedition was to meet with little more success than had the Brest assault.

The Admiral wrote to Shrewsbury from Barcelona in early August his conviction that the French would not appear and fight, and confessed he thought Toulon too well guarded to risk the fleet in that harbor.[38] Realizing the fickleness of the public temper, he confided to the Duke that he fully expected to be blamed for not fighting the French, whether they would offer battle or not. "I long to be rid of this troublesome affair. I have

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[35] Russell to Trenchard, July 25, 1694, CSPD, *1694–5*, p. 239.

[36] J. K. Laughton (editor), *Memoirs relating to the Lord Torrington* (Camden Society, 1889), p. 68; Sourches, *op. cit.*, IV, 354; Quincy, *op. cit.*, III, 86; Luttrell, *op. cit.*, III, 361.

[37] Russell to Trenchard, August 3/13, 1694, CSPD, *1694–5*, p. 252. Russell felt his position in the Mediterranean to be precarious. "With only four weeks to go before his big ships should be taken into harbour, he was over 1600 miles from home and with a hard passage ahead of him. A shift of wind to the West for a week and he was caught inside the Mediterranean with no major base and with the Atlantic and the autumn between himself and Portsmouth." Ehrman in *Cambridge Historical Journal*, IX, #3, p. 286.

[38] This is the same view that he had tendered Trenchard. Russell was correct in his observations, if Sourches, among many others, can be taken as authoritative in his remarks upon the French success in fortifying Toulon. *Op. cit.*, IV, 357.

neither head, body, nor temper to undergo all I do. Pray . . . that I may have the good fortune to see you at Christmas."[39]

But such was not to be the Admiral's good fortune. At Malaga in early September of 1694, Edward Russell met with one of the greatest surprises of his life: he was ordered to remain in the Mediterranean area during the winter, and to establish quarters at Cadiz.[40] This move on King William's part is considered by Corbett to be the masterstroke of late seventeenth-century English naval policy. So important does Corbett deem this establishment of a semi-permanent Mediterranean fleet that he indulges in fulsome praise of William III's action:

> So the momentous step was taken to adorn William's memory with one of its finest ornaments. It was he and he alone whose act it was, and his should be the undying credit. For the honour of his ungenerous ministers, it must be said that, when he had once assumed the responsibility, they did all they could to support him.[41]

Though, as Corbett says, "it was he and he alone whose act it was," Burchett speaks of a similar proposal: "at this time (late summer of 1694) a noble Lord (Earl of Gallway) proposed the fleet's wintering in the Mediterranean . . ."[42] In extenuation of Corbett, many may have had the idea; William III did put it into execution! Suffice it to say that by September 7th Russell had acknowledged the royal orders, and had written of his compliance to Shrewsbury, detailing the shortcomings and defects of the fleet, sneering at the King, who "fancies the defects of a ship are as easily repaired as mending a bridle or stirrup leather," and outlining his further plans for the aid of Spain.[43]

By October the fleet was at Cadiz, its designated winter base.[44] Russell set to work to make the port as suitable a winter station

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[39] Russell to Shrewsbury, August 3/13, 1694, Coxe, *op. cit.*, p. 199.

[40] Draft (with the Queen's signature) of instructions for Edward Russell, Esq., Admiral of the fleet, August 14, 1694, CSPD, *1694–5*, p. 264.

[41] Corbett, *op. cit.*, II, 444: See also Blathwayt to Trenchard, July 27/August 6, 1694: "His Majesty has now declared his Pleasure concerneing Admiral Russell's return home and commands me to lett you know that he is Inclined that the Fleet should remain in the Mediterranean as long as may consist with its safety, and that upon Admiral Russell's coming away, he leave as considerable a squadron as may be convenient in those parts." Add. Mss. 37992, f. 58, quoted by Ehrman, *Cambridge Historical Journal,* IX, #3, p. 286.

[42] Burchett, *op. cit.*, p. 507. As Ehrman points out, however, William III's policy had been more foresighted: "From his vantage point at the head of an alliance, with his varied sources of information of which he alone knew the sum, and with his European interests which separated him from all his English ministers and of which he alone had always been acknowledged to be the judge, William looked at the Mediterranean with a different eye from that of the authorities at home. To him, it was now the point at which allied sea power impinged upon allied strategy." *Cambridge Historical Journal,* IX, #3, p. 275.

[43] Russell to Shrewsbury, September 7, 1694, Coxe, *op. cit.*, pp. 202–4.

[44] Russell to Shrewsbury, Alicante, September 21, and Cadiz, October 8, 1694, Coxe, *op. cit.*, pp. 204, 205; S. Martin–Leake, *Life of Captain Stephen Martin* (Navy Records Society, 1895), p. 23, claims October 7th as the date of Russell's arrival

as possible, and to refit the Anglo-Dutch fleet for future action in the Mediterranean, always touching his observations of his work with characteristic pessimism: "if it be possible to serve at sea eighteen months," he wrote Shrewsbury, "I may hope to see you again; if not, my cares about my house and garden will be at an end."[45] And while Russell stood at Cadiz, the French wintered at Toulon,[46] and thus affairs rested through the winter.

William III, it is clear, had every intention of keeping Russell at his post during 1695, and wanted from Russell the exact date when the Anglo-Dutch fleet would be ready to put to sea, for he had certain concrete proposals in mind: English trade in the Mediterranean must be protected; the Catalonian coast in particular, and Spain in general, must be defended;[47] the fleet should be ready, if possible, to join in action with the Duke of Savoy and Lord Galway in a descent upon Provence. Bombardment of Toulon was also to be given serious consideration, for if the bomb-vessels could get close enough, they might wreak terrible havoc in view of the extraordinarily large concentration of ships there. The same consideration was to be given for an attack on Marseilles. William furthermore wanted Russell to consider the possibility of bombarding the towns themselves if the French fleet moved out before the English fleet could effect a counter move, or if the harbor itself should prove too well defended. "At such a time as this," wrote Shrewsbury to Russell, "when there appears to be a prospect of doing something to weaken France in their naval power, which is so immediately the interest and security of England, his Majesty is earnestly concerned that such an opportunity be not lost, which in an age may not offer itself again."[48]

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at Cadiz. See also Burchett, *op. cit.*, p. 513; Shrewsbury to Blathwayt, September 25, 1694, *Buccleuch Manuscripts*, II, 140. William refused as well to consider an alternative port for the fleet, Shrewsbury informed the Spanish ambassador, and insisted that the fleet winter at Cadiz. See also Sourches, *op. cit.*, November 22, 1694, IV, 402.

[45] Russell to Shrewsbury, October 21, 1694, Coxe, *op. cit.*, pp. 209–10. Russell had written to Trenchard in a similar vein in early September: "I am at present under a doubt with myself whether it is not better to die." CSPD, *1694–5*, p. 293.

[46] Russell to Trenchard, October 29, 1694, *Buccleuch Manuscripts*, II, 154; *Memoires de Noailles*, I, 307.

[47] These were stressed in Council meetings in May of 1695. *Cf.* Privy Council minutes, May 4, 1695, *Buccleuch Manuscripts*, II, 182–4.

[48] Shrewsbury to Russell, December 4, 1694, *Buccleuch Manuscripts*, II, 162. That the Ministry hesitated to commit itself to a hard and fast policy regarding Russell's remaining in the Mediterranean over the winter is evident in its recommendation to William: ". . . if the King be inclined to have Mr. Russell remain in the Straights his Orders should not be to (sic) positive, but that he may have liberty to return, if upon notice of what supplyes he may expect from England, or upon other consideration of the state of the fleet under his command; he shall judge it not practicable to refit it at Cadiz in due time." National Maritime Museum, Bibliotheca Phillippica I, f. 212, quoted by Ehrman, *Cambridge Historical Journal*, IX, #3, p. 286. As usual, the ministry shifted the burden of decision to the King, and ultimately it was Russell who had to make the decision as to the proper course of action.

With the advent of spring, Russell stood ready to put to sea,[49] and with the arrival of suitable supplies and reinforcements from England, set out.[50] Though hampered by adverse weather, by May 10th Russell and the fleet were out of Cadiz Bay, heading for Barcelona.[51] Joining with the Dutch fleet,[52] the Admiral went in search of the French, then went to aid in the siege of Palamos,[53] finally moving off to stand in at Toulon and observe the preparations of the French fleet. The weather proved so unpredictable, however, that Admiral Russell was forced to withdraw from the coast; his appearance had given the French a great scare, nonetheless, for they had not expected him again on the coast of Provence.[54] Unable to find out for certain what the French intended to do, Russell surmised that their aim was to make a run for the Straits. As for Spain, Russell despaired of their soldiery: "nothing but a high mountain or an unfordable river is security sufficient for such miserable creatures, with officers at the head of them who are no soldiers."[55] ". . . now I shall leave them to God and themselves; and if Providence does not protect them, against all their own endeavours, Spain must be a prey to any that will demand it."[56] From Toulon the fleet withdrew to Altea Bay, and there received news of Rooke's succeeding to the command of the Mediterranean fleet.[57] Now

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[49] Burchett, *op. cit.*, pp. 517–8.

[50] Russell to Shrewsbury, April 12, 1695, *Buccleuch Manuscripts,* II, 180; *Present State of Europe,* May, 1694, p. 175; Quincy, *op. cit.*, III, 179.

[51] Russell to Shrewsbury, *Britannia,* in Cadiz Bay, May 2, 1695, Coxe, *op. cit.*, p. 229; Newsletter to Derwentwater, June 1, 1695, London, CSPD, *1695, Addenda,* p. 339. Derwentwater's informant merely knew that Russell had quit Cadiz Bay by May 8th; he knew not where he had gone. *Cf. Present State of Europe,* June, 1695, p. 206. The Privy Council and the King were most interested in the protection of the trade, the coast of Spain, and particularly in keeping Barcelona from the hands of the French. Privy Council Minutes, May 4, 1695, *Buccleuch Manuscripts,* II, 182, 183.

[52] *Torrington's Memoirs,* pp. 72–3; Quincy, *op. cit.*, III, 180. On May 21, Russell and the fleet were at Cape de Rose. Galway to Shrewsbury, June 3, 1695, *Buccleuch Manuscripts,* II, 187. Galway was in camp before Casal. See also, Russell to Shrewsbury, *Britannia,* 6 leagues south of the Isles of Hieres, June 14, 1695, Coxe, *op. cit.*, pp. 231–2.

[53] Quincy, *op. cit.*, III, 176–8. Quincy sets the figure at 3000 men for the English troops.

[54] Sourches, *op. cit.*, V, 50, 52, 54–5; *Present State of Europe,* September, 1695, p. 335.

[55] Russell to Shrewsbury, August 16, 1695, Coxe, *op. cit.*, pp. 238–42.

[56] Russell to Shrewsbury, *Britannia,* in Altea Bay, September 4, 1695, Coxe, *op. cit.*, p. 244; Quincy, *op. cit.*, III, "Quoique celles (Anglo–Dutch in 1694–5) qu'il fit fussent asses considerables pour allarmer le Roy d'Espagne ey ses peuples, alles ne purent l'amener au but que e France s'etoit propose, qui etoit de faire la paix." Page 98.

[57] Shrewsbury wrote to tell Russell the news of Rooke's appointment: "The truth of the matter is, to oblige you to stay longer, would have been a barbarity to you, and your not staying is a cruelty to the public." July 30, 1695, Coxe, *op. cit.*, pp. 233–4. See also, Lord Capel to Mr. Vernon, August 15, 1695, CSPD, *1695,* p. 45. Shrewsbury had expressed his belief to Russell as early as May that Rooke would be the Admiral's successor: May 21, 1695, *Buccleuch Manuscripts,* II, 186. See also Sourches, *op. cit.*, V, 21–2.

Edward Russell's sojourn was nearing its end, and his work was nearly finished. Care for the weakened fleet was of paramount interest to Russell; he left what ships he could for Rooke, and beat up the Atlantic coast with the remainder of the Anglo-Dutch fleet. Making the passage from Cadiz in twenty-two days of fine weather, Edward Russell was at Portsmouth on November 4th, and two days later he struck his flag at Dover and went ashore.[58]

The Admiral was home at last, and he could cast his glance back over eighteen months of activity in the planning and execution of the Mediterranean expedition. He had failed to destroy the French fleet, but he had kept it bottled up at Toulon and Marseilles. He had failed to bombard or destroy in part the towns or harbors at either of those two ports, but he had succeeded in keeping the French from capturing Barcelona, and had limited them to their gains in Catalonia secured prior to his arrival. He had failed to concert a land and sea action with Lord Galway, not because he was unwilling to co-operate, but because the Duke of Savoy either could or would offer no assistance. He had managed to keep the fleet ready for sea duty, and this in spite of poverty-stricken facilities at Cadiz, and long-delayed supplies from England. Intent on searching for the French, he had been obliged to aid in the siege of Palamos, transport troops from Italy to Barcelona, and attempt to force action and decision from lazy, shiftless, indecisive and disinterested Spaniards, many of whom were more in the interests of France than of Spain. If the whole campaign seems in general scope frustrated, it appears, upon detailed analysis, about as successful as it could have been in view of the odds against the Admiral.

There were other concrete gains that cannot be overlooked. Most important was the new prestige that England had gained in the eyes of the Mediterranean and Italian city states, and in the eyes of the maritime powers. France's fleet had not been beaten, but it had been immobilized and prevented from aiding her land forces to put Catalonia out of the war. The preponderance which France held in the Mediterranean immediately after the destruction of the Smyrna Convoy in 1693 had amounted to nothing when the English fleet had come into the Mediterranean; Spain had been kept intact and at least temporarily on the side of the Allies: all this by one Anglo-Dutch fleet. The respect that William's government had gained among the previously recalcitrant Italian city states was phenomenal. All in all, Edward

[58] Luttrell, *op. cit.*, III, 546, 547, 548; CSPD, *1695, Addenda*, pp. 350, 353; *Torrington's Memoirs*, p. 77; Martin-Leake, *Life of Captain Stephen Martin*, p. 24.

Russell had served well in his appointed task. Under his command and at his discretion, the policy that was to prove one of the bulwarks of later Empire had been inaugurated. The reputation of England was much greater for Russell's having sojourned in the Mediterranean sea, and King William was under obligation to thank his enterprising but querulous Admiral for his valuable services, nautical, diplomatic and military.

THE DISTRIBUTION OF SOILS AND SLOPES ON THE MAJOR TERRACES OF SOUTHERN RICHLAND COUNTY, WISCONSIN

F. D. HOLE, F. F. PETERSON, and G. H. ROBINSON[1]

In the course of the soil survey of Richland County,[2] Wisconsin (1947–48), the authors collected information about the soils, slopes, and elevations on stream terraces as a contribution toward an understanding of the genesis of the terraces and of the soils.

THE TERRACES OF SOUTHERN RICHLAND COUNTY

Uber (1916), MacClintock (1922), and Thwaites (1928) have described the Wisconsin and pre-Wisconsin terraces of this part of the Driftless Area. A correlation is made of the work of these men in Table 1.

The authors have separated the terraces on the basis of: a) elevations taken at many points on each terrace (Peterson, 1950); b) graphic projections of terrace surfaces down the tributaries to meet the terraces in the main Wisconsin River valley; c) terrace escarpments observed in the field and by stereoscopic inspection of aerial photographs of the area. No distinct escarpments were found between terraces numbered 4, 5, and 6. Heights of terraces above the present streams were found to be neither constant nor reliable for correlation. Grades average about one and a half feet per mile in the Wisconsin River valley and two to three times this in the lower Pine River valley.

These terraces occupy an area of approximately 40 square miles in southern Richland County, of which area terrace 1 occupies 36%, terraces 2 and 3, 20% each; terrace 4, 7%; terrace 5, 17%; and terrace 6, 0.1%. One fifth of the soils[3] were classified as prairie soils (developed under prairie vegetation), and the remainder as timbered soils (developed under native forest). The natural drainage conditions of the soils were determined according to the catena concept (Bushnell, 1944) and 58%

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[1] Assistant Professor of Soils, Assistant in Soils (1948–49) at the Univ. of Wisc., and Soil Scientist, Div. Soil Survey, Bur. Plant Indust., Soils, & Agr. Eng., respectively.

[2] The soil survey of Richland Co., Wis. was made by the Div. of Soils, Wisc. Geol. & Nat. Hist. Survey, the U.S.D.A., and the Soils Dept., College of Agriculture, Madison.

[3] For descriptions of the soil series mentioned in this paper, see the Provisional Wisconsin Soil Key by G. H. Robinson, available at the Soils Dept., College of Agric.

of the soils by area were found to be well drained, 27% excessively drained, and 14% moderately to poorly drained. The proportion of imperfectly drained soils increases as one goes up the tributary valleys. This percentage changes from zero near the Wisconsin River to about 17% at six to ten miles up the tributary valleys. Slopes were mapped according to the classification used by the Soil Conservation Service in Wisconsin.[4] Of the total area of the terraces, half has A slopes; 28%, B slopes; 10%, C slopes; and 2% D, E, and F slopes. The remaining areas have complex slopes (dune topography), half with grades of less than 12% and half with steeper slopes.

TABLE 1

DIFFERENTIATION OF TERRACES IN SOUTHERN RICHLAND COUNTY, WISCONSIN

By Uber	By MacClintock	By Thwaites	By Hole, Peterson, and Robinson		
		Pre-Wisconsin Terraces	Terrace Numbers	Diagnostic Soil Series Present	Soil Parent Materials in These Series
Very high (117 to 123-foot)	Older terraces	Kansan?—190-foot 150-foot	6	Rockbridge	30″ or less of silt cap on old reddish brown gravelly colluvium and alluvium.
		Illinoian?—100-foot 80-foot	5	Bertrand and Plainfield*	36″+ of silt cap on outwash. Dune sand.
High (50 to 80-foot)		60-foot	4	Tell	30″ or less of silt cap on outwash.
	Wisconsin terraces	Wisconsin terraces			
Intermediate (27–60-ft.)	High	Cary—40-foot	3 2	Meridian, Bertrand Medary	Outwash; 36″+ silt cap on outwash. 30″ silt cap on red lake clay.
Low (14 to 24-foot)	Low	Late Cary—20-foot	1	Sparta* and Plainfield*	Outwash sand.
Flood Plain	Flood Plain	Valders—Flood Plain	....	Alluvial soils, undifferentiated.	

*Includes sand dunes.

[4] A slopes, 0–2%; B slopes, 2–6%; C slopes, 6–10%; D slopes, 10–15%; E slopes, 15–20%; F slopes, 20–30%; G slopes, 30% +.

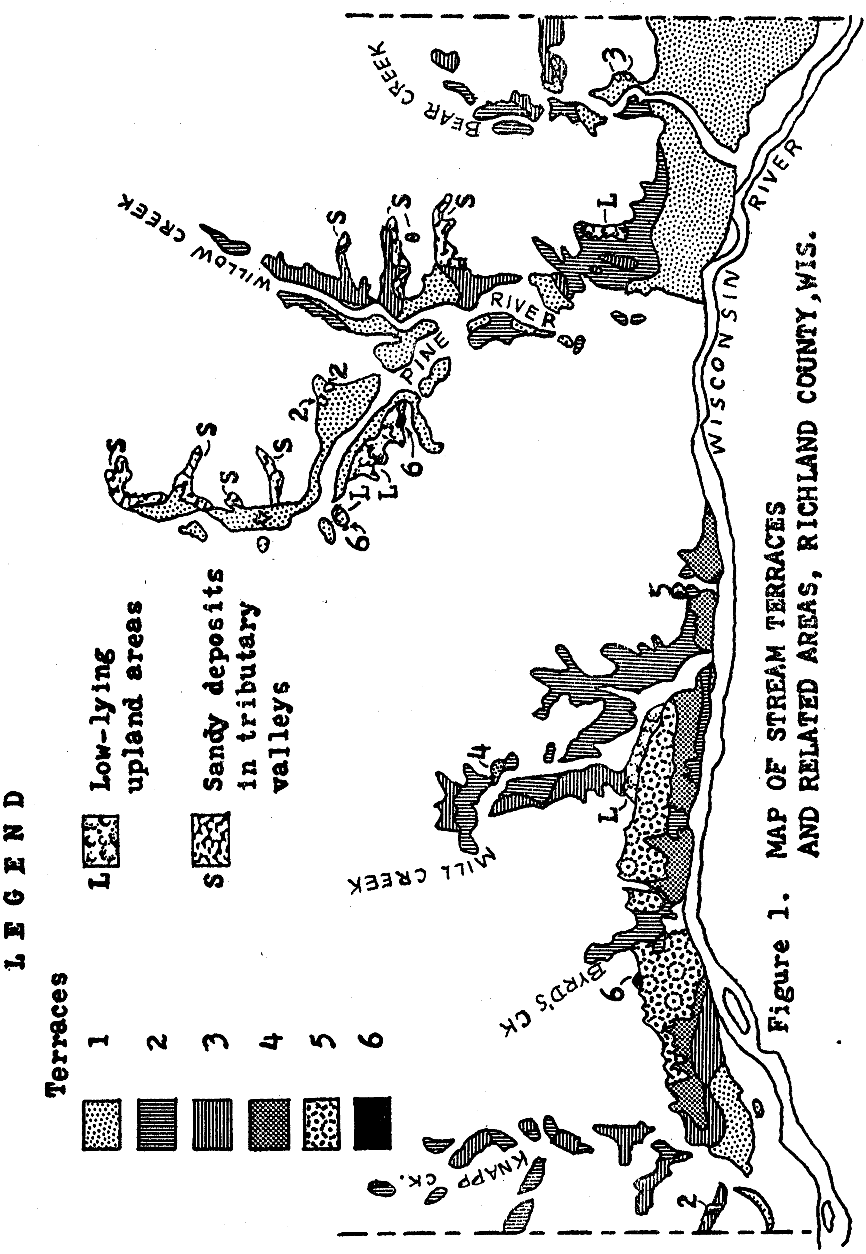
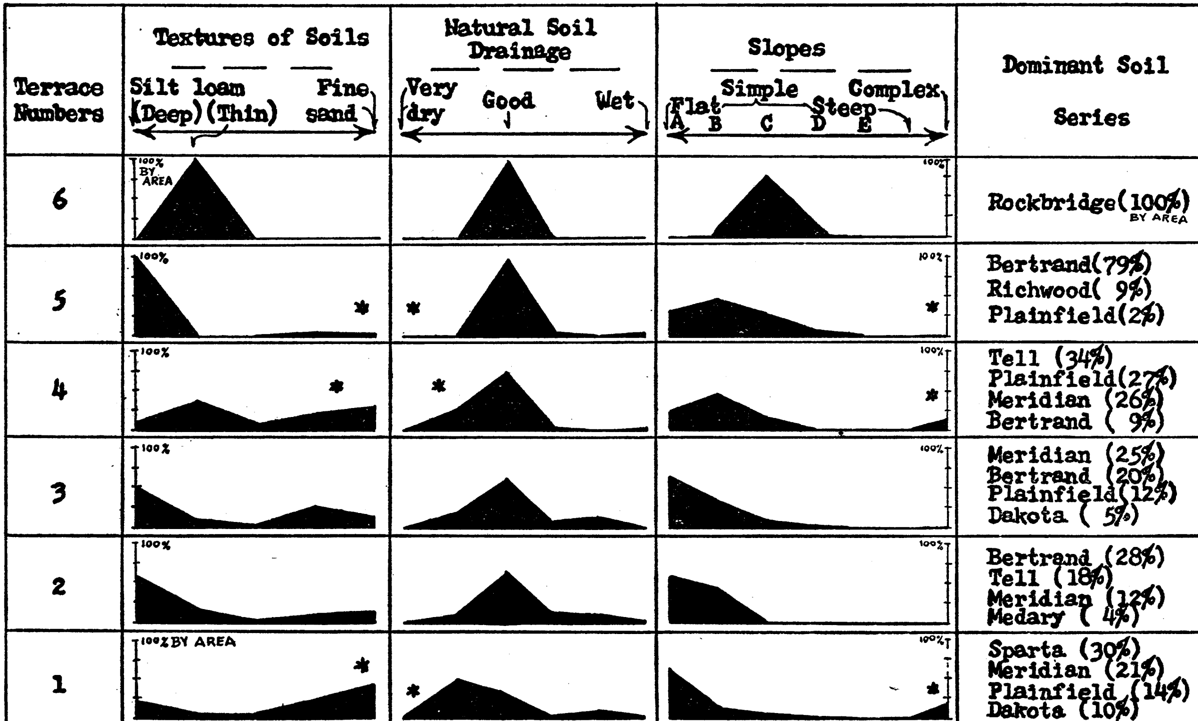


Figure 1. MAP OF STREAM TERRACES AND RELATED AREAS, RICHLAND COUNTY, WIS.

FIGURE 2.

SUMMARY OF SOIL AND SLOPE DATA FOR TERRACES IN SOUTHERN RICHLAND COUNTY, WISCONSIN



* Dunes present

Figure 1 is a sketch map of the areas in question and Figure 2 presents a summary of the soil and slope data for the individual terraces.

Low-Lying Smooth Areas of Upland Soils

Relatively smooth areas of upland soils which lie adjacent to the terraces were found at three places in southern Richland County: between Eagle Corners and Balmoral, northeast of Gotham, and just south of the Pine River in southern Richland Township. At the first location, the low-lying upland with Fayette and Downs silt loams stands at 130 to 200 feet above terrace number 6, or 290–360 feet above the Wisconsin River. Near Gotham, Norden loams occupy an area of smooth upland lying 75 to 115 feet above the Pine River, and 40 to 80 feet above adjacent terrace number 2. In southern Richland Township, Fayette and Downs silt loams occupy a sloping rock shelf which rises from the level of terrace number 1 to that of terrace number 6. Silty upland soils occupy 70% of these areas, and loams, the remainder. Drainage is good but not excessive. Seventy-three percent of the slopes by area are C slopes, 16% are D slopes, 9% B slopes, and 2%, E and F slopes. These upland areas probably represent ancient rock benches cut by streams.

Areas of Loamy Fine Sand Related to the Terraces of the Pine River and Willow Creek

In the vicinities of Richland Center, Aubrey, and Sextonville, areas of loamy fine sand occupy the southern valley slopes of tributaries which flow west into the Pine River and Willow Creek. The adjacent terraces are dominantly loam in texture, and merge into the loamy fine sand slopes, which rise at grades of 3% to 28% and which reach as high as 70 feet above the terrace. It seems reasonable to suppose that these loamy fine sands are Chelsea soils, developed from an aeolian deposit derived from the near-by terraces, although resemblance of the soil profile to that of the Plainfield soils has led some surveyors to regard the gently sloping areas as terrace remnants.

Preliminary Estimates of the Ages of the Silty Soils on the Terraces and Adjacent Uplands

A loess deposit two to four feet in depth was made over this area[5] long enough ago for the development to take place on the

[5] See map of Areas Having Aeolian Silt and Sand Deposits in Wisconsin, Div. of Soils, Wis. Geol. and Nat. Hist. Survey, 1950.

uplands of deep, acid soil profiles with distinct textural B horizons.

The Rockbridge silt loam[6] on terrace number 6 is a shallow soil with at least part of the B horizon developed in the silt. The shallowness of this soil may indicate that the original loess deposit was thin on the slopes of these high terrace remnants, or that geologic erosion has been active there.

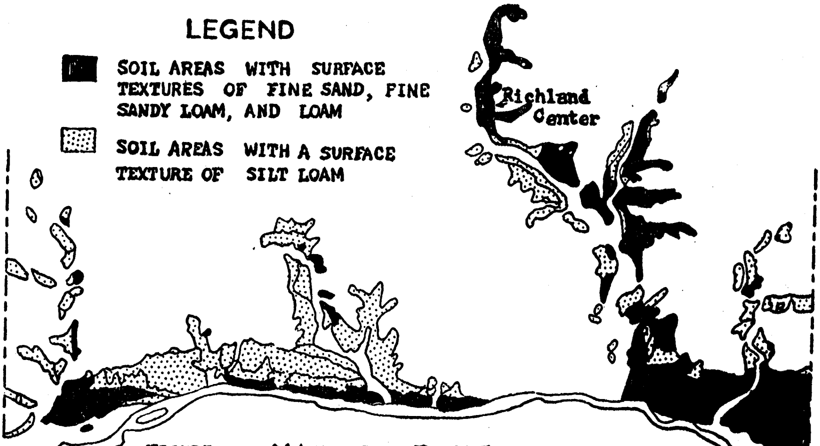


FIGURE 3. MAP OF TEXTURES OF SURFACE SOIL, SOUTHERN RICHLAND COUNTY, WIS.

Studies by Robinson (1950) in adjacent Grant County, Wisconsin, indicate that the Fayette soil, developed from deep loess on uplands, and leached to a depth of about 7 feet, is about 20,000 years old. The corresponding soil on the terraces is the Bertrand silt loam, which has a slightly more developed B horizon than does the Fayette soil. No data on depth of leaching in the Bertrand soils is obtainable, however, because the silt deposits from which they developed are relatively shallow and are entirely leached. The presence of a textural B horizon is not a reliable index of age, as is the extent of carbonate removal. Fifty-three percent of the Bertrand soil areas in southern Richland County are found on terrace number 5. The soil survey showed that Bertrand soil also occurs on all the lower terraces. Of the total

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[6] Peterson gives the following section from a road cut in the NW ¼ NW ¼ Sec. 2, T. 9 N., R. 1 E.:

20″—Solum of Rockbridge silt loam developed in loess.
16″—Sandy clay loam and small cherty gravel.
13″—Red clay.
24″—Blue clay.
+ —Cherty gravel bedded with sandy clay loam.

area of Bertrand soil on the terraces, 2% is on terrace 4, 17% on terrace 3, 23% on terrace 2, and 4% on the first terrace.

Robinson estimated the age of the Medary soil, which developed from a shallow silt cap over red calcareous, lacustrine clay, to be about 8,000 years. This would fix the age of the soil on terrace number 2. The limited information on probable ages of soils of the area may be summarized as follows:

Upland soils developed from loess	20,000 years old
Soils developed from silty deposits on terraces 3, 4, 5, 6	8,000 to 20,000 years old
Soils on terrace 2	8,000 years old
Soils on terrace 1	less than 8,000 years old

The terraces proper must be older than their silty soils which developed from loess.

The Textural Pattern of the Soils of the Terraces and Related Areas

A map (Figure 3) showing the distribution of sandy soils and silty soils reveals that the sandy areas lie a) adjacent to the Wisconsin River, and b) on the east side of tributaries entering from the north. This suggests that there was a) active stream cutting which removed considerable portions of the older terraces, after which sandy terrace number 1 was constructed, followed by b) a period of erosion which was dominantly aeolian. It seems probable that wind removed silty material from the higher terraces in those areas lying close to the Wisconsin River. Wind action could account for the presence of sandy deposits in small west-flowing tributaries to the Pine River and Willow Creek. The sandy first terrace could very well have been the source area for the sand. Deposits of silt on the first terrace on the west sides of the large tributary valleys could have been made by wind and colluvial wash, which moved soil material down from the adjacent uplands. The presence of a textural B horizon in silt loams both on the steep valley slopes and on the first terrace indicates however, that this movement took place at least centuries ago.

Related Problems

Several related problems need attention:

1. It is possible that analyses would reveal differences between the B horizons of silty soils on the various terraces. In 1948, soil surveyors in Grant County distinguished between a normal soil on the high terraces and a "poorly developed" phase of the same soil on the lower terrace.

2. A series of auger borings to a depth of 5 to 25 feet would provide needed information on the materials in the terraces.
3. A detailed topographic map would help in the correlation of the terraces.
4. A study of the mineralogy of red clays of the Medary (terrace No. 2) and Rockbridge (terrace No. 6) soils, of the Dubuque soil on the upland, and of the deposits on the floor of Eagle Cave in Eagle Township would be useful.
5. An explanation is needed for the high pH of the sandy deposits in the west-flowing tributaries to the Pine River and Willow Creek. Mineralogical analyses of these sands, of the sands of the first terrace and of the sandstone strata of the surrounding hills might prove valuable.

FIG.4

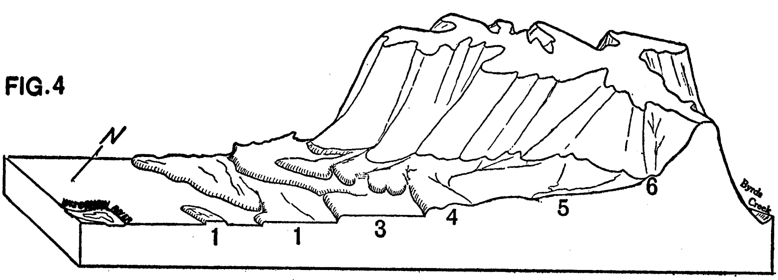

DIAGRAM OF STREAM TERRACES, RICHWOOD TOWNSHIP
RICHLAND COUNTY, WISCONSIN

Summary

The soil survey of stream terraces (see Figure 4), three low-lying smooth areas of upland, and of deposits of sand in small tributaries in the southern half of Richland County, Wisconsin, reveals complex soil and slope patterns. Detailed correlation of the terraces by means of elevations, projections, and escarpments can be only approximate for some of the terrace remnants. Determination of age of the soils can at present be attempted only for those with calcareous parent materials.

A few relations are apparent, however. The lower terraces are more level and more sandy than the higher ones. The silty soils of all the terraces appear for the most part to be developed from loess, although some effects of creep colluvial and alluvial wash are apparent. A major deposit of loess was made in the area about 20,000 years ago. Some wind erosion (by west winds) and redeposition of sand and of loess have taken place since then, over a period of approximately 12,000 years.

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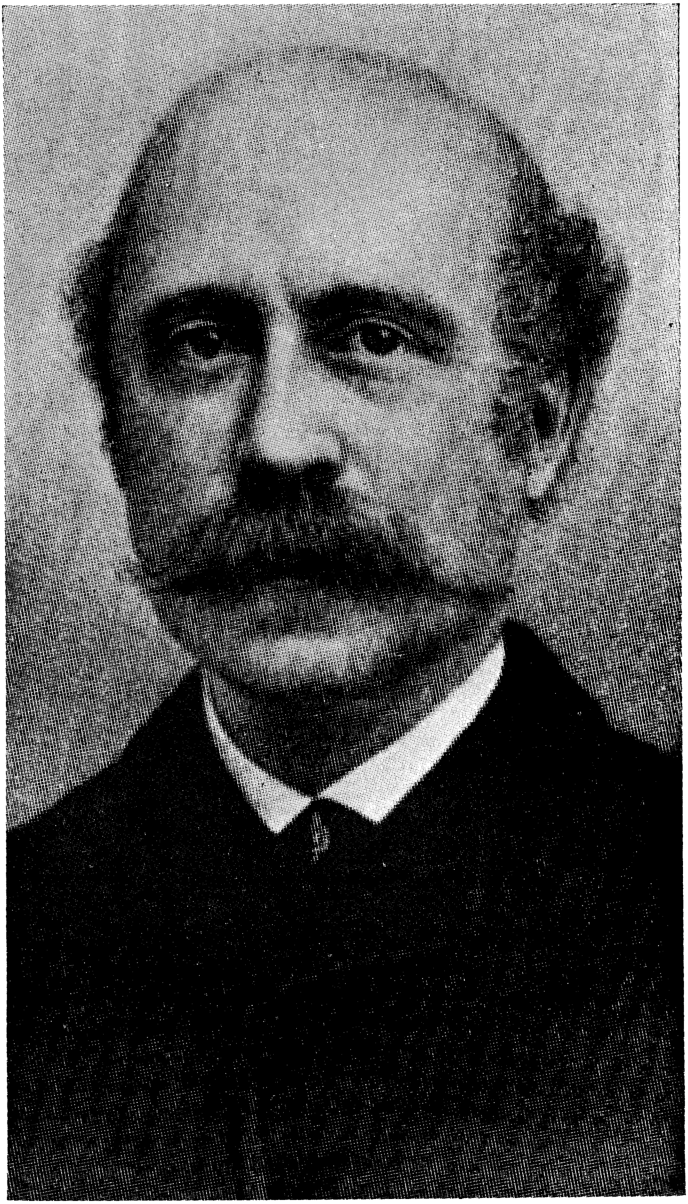

Henry B. Nason

THE CHEMICAL SOCIETY OF BELOIT COLLEGE 1863–66

PAUL W. BOUTWELL

On December 14, 1863, The Chemical Society of Beloit College was organized. The secretary's book is still in existence, and for many years it was in the hands of Dr. G. L. Collie, Professor Emeritus of Anthropology of Beloit College. Several years ago he turned the old minutes over to the Chamberlin Science Club for preservation. From this original source, and from the files of the *Beloit College Monthly*, it is possible to gain an insight into the nature of this early society.

According to Dr. Edgar F. Smith (6) the first chemical society in the world was the Chemical Society of Philadelphia, founded by James Woodhouse in 1792. This society lived for about seventeen years, and was succeeded in 1811 by the Columbian Chemical Society. (1) Some years ago this claim was contested by Dr. James Kendall of the University of Edinburgh. (5) He brings to light evidence of a rather convincing nature that this was not the case. In a paper in the Journal of Chemical Education he says, "Among the correspondence of Joseph Black, Sir William Ramsey discovered a piece of paper of which only the date, 1785, was in Black's handwriting entitled, 'List of the Members of the Chemical Society'." On investigation by James Kendall the membership was from Black's own class in chemistry at Edinburgh. "It displaces the Chemical Society of Philadelphia as the first chemical society in the world," says Kendall, who then points out that "the University of Pennsylvania was founded (1765) under strong Edinburgh auspices. John Morgan who first taught chemistry there, and Benjamin Rush who succeeded him in 1769 as the first full-time professor of chemistry in America, were both students of Joseph Black in Edinburgh, and when James Woodhouse founded the Chemical Society of Philadelphia in 1792, he may quite plausibly be pictured as following consciously and deliberately in the footsteps of Joseph Black." (5)

At the time of the founding of the Chemical Society at Beloit College there were similar societies at Union and Columbia Colleges. (3) The Beloit Society was closely patterned after that at Union College. How many such early chemical societies existed in the colleges we do not know. It was not until 1876 that the American Chemical Society was founded. Previous to this time a number of local societies existed in several of the cities. There seems to be no doubt that this organization at Beloit College represents one of the very early college chemical societies.

For over a century chemistry has been taught at Beloit College. During the early years of its history the College was particularly fortunate in the calibre and training of the men who guided the teaching of science. In 1849 Dr. Stephen Pearl Lathrop came to Beloit from Middlebury College as the first professor of chemistry and natural science, later to become the first professor of chemistry at the University of Wisconsin. He was followed at Beloit, after a short interim, by Dr. Henry B. Nason who filled the same chair from 1858 to 1866. Professor Nason was an Amherst graduate, as were the next three professors of chemistry who succeeded him. They were Elijah P. Harris, James H. Eaton and Erastus Gilbert Smith. Their combined services, except for a few brief intervals, cover sixty-three years in the life of the College. "All received their doctor's degree at the University of Goettingen, Germany, under the immediate supervision of the distinguished chemist and teacher, Geheimrath Professor Fr. Woehler." (4) Professor Nason was the first of this group. Fresh from his training in Germany he brought with him tremendous energy and enthusiasm for his work. He divided his time between Beloit and the Rensselaer Polytechnic Institute at Troy, N. Y., to which institution he went permanently in 1866, and served there until his death in 1895. He had a distinguished career as an author and teacher, and was in 1890 made president of the American Chemical Society.

Professor Nason was warmly received by the students at Beloit. The popularity and effectiveness of his work is attested by the references found in the *Beloit College Monthly* of that time. (2) That field trips are not a recent invention is shown by the account of a trip to the mines at Galena and Mineral Point in 1861 under the direction of Professor Nason. Here one gets a picture of the life and thought of the time. The editor goes on to remark, after describing the trip, "Modern Science and discoveries, if they have given the world much, have also deprived it of much. Knowing the 'whys and wherefores' may satisfy curiosity, but at the same time, it blunts the keenness of pleasure. It takes away that exquisite thrill of enjoyment which nothing but a sense of mystery can give." There must have been quite a group of followers of Professor Nason who were led on by a desire to know more of the "whys and wherefores," and who found their thrill of enjoyment in looking into the mysteries of science. For in the *Beloit College Monthly* of December, 1863, we find that "The Chemical Society of Beloit College, founded December 18, 1863, (The minutes of the Society give the date of

December 14.) was organized for the purpose of increasing the interest in the department of Chemistry and Natural Science, the formation of a Cabinet of Natural History, chemical preparations and products, and a library of Standard Scientific Works and the leading journals relating to these subjects." The list of officers then follows with Professor Nason as president. The reference goes on to say, "The Society has already quite a library and also a cabinet of Natural History connected with it. During the next term there will be lectures weekly before the Society by its members." Further on it is stated, "During the last month, we have been favored with lectures by Professors Nason and Blaisdell. The first gave a very interesting account of his travels in Europe."

In the section of the *Monthly* for February, 1864, entitled "Collegiana," the popularity of Nason as a lecturer is again indicated: "Professor Nason's lectures before the Chemical Society, to judge from the crowd of citizens and citeyennes [*sic*] that attend them, are a decided success. We think that his exertions for the College are worthy of all praise. The Chemical Society is the fruit of his unaided efforts. Three years ago, assisted by the musical talent of the College and the town, he represented the catanta of the Haymakers for two nights, and thus cleared one-hundred and twenty-five dollars for the purpose of purchasing an organ for the College choir. . . . Professor Nason would deserve the thanks of all interested in the College for the exertions he has made for his own department, until we have now one of the best sets of chemical apparatus in the country; and these and many other additional services only increase our debt to him."

An earlier number of the *Monthly* (Feb. 1863) describes the new apparatus of the College. "By recent purchase in Europe, many valuable instruments have been added to the Philosophical as well as the Chemical Cabinet. Now the main points of nearly all the branches (of Philosophy) can be successfully illustrated. Hydrostatics, Pneumatics, Electricity, and Optics are well supplied, while Mechanics, Acoustics, and Magnetism have each a few fine pieces. Among the most valuable articles are a powerful Microscope, a newly invented instrument called the Spectroscope, for spectrum analysis, and a very large Oersted's apparatus for liquefying gases and condensing liquids. Without going into tedious detail, it embraces, among other things, a Gasometer, Balance and Weights, Parabolic Reflectors, and Optical and Electrical instruments.

"The Spectroscope, manufactured by Meyerstein at Göttingen, is a fine specimen of workmanship, and is most carefully adjusted. It may be remarked, that with a similar instrument, the new elements Caesium and Rubidium were discovered by Professors Bunsen and Kirchhoff. This piece of apparatus is not possessed by any other college in the United States unless introduced within a few months." Then there follows a description of the use of the apparatus in the demonstration of the liquefying of sulfur dioxide before the chemistry class. The account of the new equipment then continues: "All the glassware for the laboratory was made at Prague, Bohemia, expressly for the College, of a superior article and of the latest and best forms. Numerous diagrams illustrating Geology and Chemical operations have also been added to the Cabinet, making in all a valuable collection. In this country these additions could probably have not been purchased for fifteen hundred dollars."

The improvements that had been made in the laboratory and other general facilities were then mentioned, and the account closes with the following: "For chemical purposes, a furnace has been built and furnished with glass compartments in which to operate with gases, without being subjected to their poisonous and offensive odors.

"These purchases were made by Professor Nason during his absence in Europe. Of the Philosophical department Professor Kelsey has charge."

In the *Monthly* for November, 1862 we find the following: "We are glad to announce the return of Professor Nason from his tour through Europe. The Seniors in particular, and the College in general, will be benefited by the increased facilities which the department now possesses for the study of the Natural Sciences." The Chemistry Department still has many rare old pieces of equipment, and the library books and journals, many in German and French, dating back to the time of Professor Nason or before. Some of the very pieces which he brought with him from his travels in Europe may still be preserved, but we have no certain way of identifying them.

In the "Collegiana" section of the *Monthly* for November, 1864, appears the following note: "The Chemical Society is in full blast. Many new names have been added to the roll this term; and through the exertions of Professor Nason, it has become a fixed institution. Although in the recitation room, the subjects discussed would seem borous [*sic*], yet here they seem necessary to counterbalance the inclination for a general good time. The Society acknowledges the receipt of the photograph of the Chemical Society of Union College. The boys are about to return the compliment. Arrangements are being made to secure a lecture for the Society at Commencement. On Nov. 11th., the Society room was illuminated with light carburetted hydrogen. Contributions are continually being added to the chemical cabinet. Corresponding members and friends of the Society are requested to contribute whatever may be of interest. Essays are read at every regular meeting. On Nov. 17th J. L. Taylor read an essay before the Society upon 'Man and the Post Pliocene Period.' At the last meeting, T. C. Chamberlin presented one upon 'Paper, its History and Manufacture.' "

The Society did not depend upon its own members for all its programs. In the February number of the *Monthly* for 1865 we find the following: "Dr. Gilman, of Rockford, lectured before the Chemical Society on the evening of January 17, on 'Coral Formations.' An opportunity was thus offered to the students of displaying a fifteen-cent liberality for the sake of female society, which was so far improved that the Society netted a sum far beyond the expectations of the most enthusiastic 'Curator.' On Friday, Feb. 3rd., Professor Nason delivered a very interesting lecture before the Chemical Society—Subject, 'The Sun.' On Friday, the 17th inst., a lecture was delivered before the same society by Professor Carr* of Madison—Subject, 'The Atmosphere.' " Then followed the note: "Professor Nason has left us for the summer term and has gone to Troy, N. Y. We all regret his departure and will welcome his return." Later, in October of 1865, we find the note: "We regret to state that Professor Nason has been prevented by sickness from resuming his teaching here as yet this term. Those of us who have Greek twice a day look anxiously for his appearing." In the November number of that year we find that "Professor Nason has recovered so far as to resume his duties here. . . . The boys are swaggering about, rejoicing in the barbarous names of Chemistry, Geology & c."

It is surprising that the Chemical Society could carry on at all during these Civil War years. Only an occasional reference to the war is found in the *Beloit College Monthly* for this period. The following item from the *Monthly* for November, 1863, shows again that Professor Nason's interest extended beyond the limits of his own field: "Through the active exertions of Professor Nason, the spirit is beginning to move. Cartridge boxes, bayonet sheathes and belts have arrived for use of the 'cadets,' and are now in the care of Capt. Sheratt. May the muskets come soon—not by draft but otherwise." It is interesting to note that at this time following the close of the Civil War, the enrollment of the College was but 75 men.

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* Ezra S. Carr, M.D., followed Professor Stephen Pearl Lathrop as the second professor of chemistry and natural science at the University of Wisconsin.

The success of the Chemical Society is again noted in the December number of the *Monthly* for 1865 where we find that "The Chemical Society under the supervision and active influence of Professor Nason, promises to be both interesting and successful. It has now a large number of members." The officers are then listed with Professor Nason again as President, and Peter Hendrickson as Chemical Editor of the *Monthly,* and with T. C. Chamberlin on the Executive Committee.* In the same reference we find that Professor Nason's interests are not limited to his own field: "By his own activity and influence, also aided by the liberal subscription of the students, especially from the higher classes, Professor Nason has been able to procure the much needed organ for the Chapel. We learn that it has arrived today, and we anticipate to see many assert their claims to membership of the choir this evening. We trust the new organ will prove a powerful center of attraction to the musical members of our college community."

The high esteem in which Professor Nason was held is again shown in the note from the February, 1866, *Monthly:* "Professor Nason is about to return to his duties in the Institute at Troy, N. Y. His departure is regretted and so are the preliminary examinations." Finally, in the number for October, 1866: "We regret that Professor Nason has resigned his position as Professor of Chemistry and Natural Science. He will be succeeded by Professor Harris of Toronto University, who is expected to commence his duties at the beginning of next term." The Professor Harris referred to has been mentioned before. He left Beloit after two years to become head of the Chemistry Department at Amherst, his Alma Mater, where he remained for thirty-nine years, and where he was the instructor of Professor E. G. Smith, who occupied the Chair of Chemistry at Beloit College for forty years.

No further references to the Chemical Society have been found. With the departure of Professor Nason the Society ceased to carry on without its guiding spirit. Its life was but three years, but in that time it left its mark on the College. Its accomplishments will always remain as a memorial to its scholarly founder.

A more intimate picture of the Society can be obtained from the original Secretary's book referred to before. (3) On page 2 of this book in the handwriting of the first Secretary, Mr. A. O. Wright, appears the following: "A meeting of the Senior and Junior Classes of Beloit College was called in the cabinet by Pro-

* The Chamberlin Science Club, organized in 1920 by the late President, Melvin A. Brannon, was named in his honor.

fessor Nason to consider the expediency of forming a Chemical Society, similar to those now existing in Union and Columbia Colleges and many universities of Europe. The meeting was organized by appointing Professor Nason Chairman, and A. O. Wright Secretary *pro tem.* On motion of A. M. May it was resolved that we do now organize ourselves into such a society. On motion of A. O. Wright that a committee of three be appointed to draft a constitution and by-laws for the society, of which the President should be chairman, the chair appointed as the other two members of the committee A. O. Wright and S. M. Allen. On motion of A. M. May the society provisionally adopted the first article of the constitution of the society at Union College, with reference to the officers and their duties. On motion of A. O. Wright the society then proceeded to the election of officers." These consisted of a president, vice-president, secretary, treasurer, librarian, chemical editor, a prudential committee of three, and three curators. There were eighteen charter members including Professor Nason who served as president throughout the life of the Society. On December 18, 1863, the Society met at the call of President Nason and elected thirteen corresponding members, most of whom were former students or graduates of the College, a considerable number of whom were in the Union armies. The secretary was instructed "to inform the corresponding members of their election and solicit their assistance in building up and promoting the interests of the Society." Among the active and corresponding members will be found the names of a number who later rose to distinction in their various fields of endeavor.

On the following day, December 19th, the Society met in Professor Nason's room and adopted the new constitution and by-laws. It was even suggested that the Society procure a charter from the legislature. President Nason "requested the members to look up and report any matters of scientific interest and present them to the Society at each meeting." At the suggestion of the President it was "resolved that the members by turns present essays to the Society at each regular meeting of next term. The members then proceeded to draw lots for the order of the evenings on which essays should be read . . . ." It was also "resolved that a fine of fifty cents be imposed on any member failing to furnish his essay at the time appointed without satisfactory excuse." At the next meeting of the Society on January 15, 1864, it was necessary to elect a new vice-president to replace the first incumbent who had resigned due to his enlistment in the army. Professor Nason was requested to deliver a course of lectures before the Society, and "to subscribe for such scientific periodicals as he saw fit, and the state of the treasury warrant. . . . Various items of scientific interest were presented, among them the discovery of a new element, Indium, by means of the spectroscope."

At the next meeting on January 23, 1864, the first paper read before the Society was delivered by the secretary, A. O. Wright, on "A Biographical Sketch of Paracelsus." In February of that year Professor Nason delivered his course of lectures on "The Air We Breathe"; "The Water We Drink"; "The Coal We Burn"; "The Soil We Cultivate"; and finally, "The Forces of Nature." These lectures, according to the minutes, were received with great interest and enthusiasm by the members, and undoubtedly, by visitors as well, for in one place the minutes refer to the crowded house which greeted Professor Nason. The lecture on coal was accompanied by an essay on petroleum by one of the members. The lecture on the soil was "listened to with very marked attention, as it covered much ground now debated in agricultural journals on the methods of restoring fertility to soils that have lost it."

With the completion of Professor Nason's lectures the program of the Society came to an end for the term. It began again after Professor Nason's return from Troy, N. Y., with the first meeting of the winter term held on Nov. 19, 1864. Several new members were elected from the junior class, including T. C. Chamberlin. New officers were elected and lots were drawn for the order of speakers for the program. "It is an interesting fact," the minutes read, "that the room is lighted this evening with that Chemical light known as C_2H_4." (The formula C_2H_4 must have then referred to acetylene, and was written on the basis of the atomic weight of carbon as 6 rather than 12.) Several references in the minutes show that both the lighting and the heating in their place of meeting was often a problem to the Society. In one instance, it is recorded, Professor Nason donated lamps for the Society to use. At the next meeting on Nov. 18, 1864, it was decided to meet every two weeks instead of every week, and to have two essays each meeting instead of one. The program for the evening was in charge of Mr. J. S. Taylor, who read an essay on "Man and the Post–Pleiocene Epoch." "An interesting experiment was presented by Professor Nason, who also announced as the result of recent research, that the metals Erbium and Terbium have been proven the same as Yttrium; also the discovery of a new element, Wasium." It was also agreed that the President procure a lecturer for Commencement.

The next meeting on Dec. 2, 1864, was the last meeting of the term. The question of a picture of the Society was referred to the Prudential Committee for arrangements. As the next meeting would be the annual meeting of the Society several amendments to the constitution and by-laws were proposed for consideration at that meeting. Professor Nason appointed a committee to arrange for the printing of the constitution and by-laws after the revision was completed. Mr. T. C. Chamberlin then read an essay on the "Manufacture of Paper" which was "duly appreciated by the Society. Mr. Chamberlin having presented to the Society specimens of the paper in different stages of its formation, a vote of thanks was moved. Professor Nason announced the Death of Prof. Silliman, Sr., of Yale College, and gave an interesting sketch of his life." At the annual meeting which followed on December 16th the President made a brief report on the condition of the Society. The photograph of the Society was deferred to next term. The Secretary was requested to subscribe for the *Scientific American, Silliman's Journal,* and the *Franklin Philosophical Magazine*. The Committee on Constitution and By-Laws reported and certain changes were agreed upon, and the Secretary was instructed to see that 200 copies were printed. No copy of this constitution has been found—only a page showing the list of corresponding and active members. There was found in the Secretary's book a copy of the Constitution and By-Laws of the Chemical Society of Union College which served as a guide for the Beloit College Chemical Society. At Union College an initiation fee of $1.00 was charged, and a regular term tax of $1.00. What the corresponding fees were at Beloit is not recorded, but the Treasurer must have had fairly substantial funds in order to provide for the purchase of books and journals. It is of interest to compare the "several departments of chemistry" as listed in the Union Constitution and By-Laws with the present classification as listed in Chemical Abstracts. We do find considerable resemblance. The list is as follows: "1. Equivalents. 2. Qualitative Analysis. 3. Quantitative Analysis. 4. Non-metallic Elements. 5. Metallurgy. 6. Organic Chemistry. 7. Vegetable Chemistry. 8. Animal Chemistry. 9. Technical Chemistry. 10. Chemical History."

In addition to the program provided by its own members the Society sponsored outside lecturers from time to time. A charge of twenty-five cents was made for general admission, and fifteen cents for students at the lecture by Dr. Gillman of Rockford. On this lecture the President reported a net profit of $1.50. While arrangements were being made for a lecture by Professor Carr of Madison, the "President presented a request from the Beloit Lecture Association that we allow Prof. Carr to lecture before them instead of before the Society,—offering to take him off our hands. On motion request was not complied with." (Minutes of Jan. 28, 1865.) Professor Nason delivered a special lecture on "The Sun" in the Chapel on the third of February, but "the inclemency of the weather debarred many from the privilege of attending. Consequently audience was quite small." Arrangements were completed for Professor Carr's lecture on Feb. 19th, when the "Chemical Society assembled in the Chapel and listened to an able and interesting lecture from Professor Carr of Madison University on 'Atmosphere in its Relation to Animal and Vegetable Life'."

One should note the importance attached at this time to the relation of chemistry to agriculture. This topic was earlier given great stress by Professor Lathrop. It was probably because of this interest in the applications of chemistry to plant and animal industry that the call came to Professor Lathrop to take up the work at the University of Wisconsin.

The absence of Professor Nason for about six months of every year while on duty at Rensselaer Polytechnic Institute interfered with the continuity of the program of the Chemical Society. Each year the Society adjourned its meetings in February or early March until November of the next school year when Professor Nason returned to the campus. At the first meeting of the new term on Nov. 3, 1863, Professor Nason raised the question of the expediency of continuing the meetings of the Society. It was voted, however, to continue. Roll was taken at every meeting and fines were imposed for unexcused absences. At one meeting it was voted that no excuses be granted members who wished to postpone the reading of their essay on the appointed date. At this same meeting it was voted that "the college bell ringer be procured to light and warm the room and that the bell be rung 15 minutes." Among the topics considered by the Society in their programs were: "Sir Humphrey Davy"; "Glass, Its History and Manufacture"; "The False and the True"; "Lead Ore and the Minerals Found With It"; "The Progress of Science and Its Relation to the Progress of the Times." At one of the meetings they were even then discussing the price of coal "which costs but $1.08 to mine." "Questions were raised about the new sense of weight." Professor Nason made mention of the arsenic eaters of Stysia, in Austria, and said that "a man had been found who daily ate four grains of arsenic." From time to time additions to the cabinet were announced, such as the valuable collection of geological specimens donated by the late Rev. Mr. Renard. It is highly probable that a number of the specimens now on display in the cases in the chemistry department date back to these early collections sponsored by Professors Lathrop and Nason, continuing through until the time of Professor E. G. Smith; and that the antique cherry cases now housing some of these collections are the very ones that housed the Cabinet referred to in these minutes. From time to time the librarian reported on the condition of the Library. At the meeting of Dec. 1, 1865, the Secretary was instructed to renew subscriptions for *Silliman's Journal of Science, Scientific American,* and *Fowles' Phrenological Journal.* Thus at an early day foundations were being laid for a valuable collection of the journals. Today the Library possesses broken files of other journals started many years ago but later discontinued. These undoubtedly reflect the changing interests of the teaching staff as well as the changing fortunes of the College. If these various journals could all have been continued an almost invaluable addition would have been made to the rich collection of old volumes in the present Science Library.

The last regular meeting of the Chemical Society was held in the Philosophy Room on Jan. 12, 1866, with Professor Nason presiding, and with H. D. Porter as Secretary. Decision as to the time for taking the picture of the Society was postponed for another meeting, probably never to occur. Mr. A. L. Norton whose excuse for postponement of his essay was earlier refused and then later granted "read an essay." This was the only case when the subject was not recorded in the minutes. "Professor Nason made an impromptu magnesium light and proposed to experiment with it. The mode of construction of magnesium lamps was explained, and experiments made both with the wire and ribbon magnesium. The light produced was most brilliant, so much so that the shadows of a flame of a candle was [*sic*] produced. The experiments were very interesting. The composition of 'Pharoah's Serpents' was given as 'sulpho-cyanide of Mercury.' Experiments were shown of these curious formations much to the delight of the members." The minutes of the Society end with the following:

"College Chapel, Jan. 26th, 1866.

"Special Meeting of the Chemical Society was called to adjourn the meeting from that evening.

"Society adjourned.

"PORTER, *Sect.* PROF. NASON, *Pres.*"

This was the last meeting of the Chemical Society of Beloit College.

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STEPHEN PEARL LATHROP
A PIONEER CHEMIST IN WISCONSIN

PAUL W. BOUTWELL

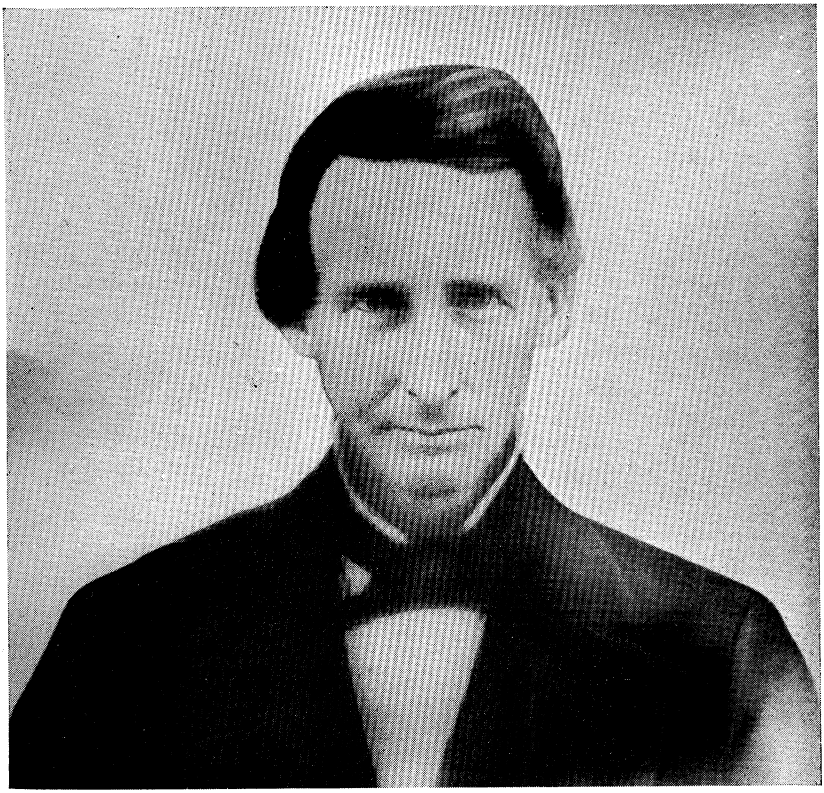
It is not until one begins to search for information concerning the life and work of some early pioneer that we find how hopelessly lost or hidden are all but the most meagre details. Such at first seemed to be the case concerning Dr. Stephen Pearl Lathrop, the first professor of chemistry and natural science at Beloit College and later at the University of Wisconsin. However, some years ago through the kindness of his daughter, the former Mrs. William H. Wheeler of Beloit, I have been furnished with much valuable material, including the original manuscripts of a number of Professor Lathrop's lectures and addresses. I am also indebted to both Mr. and Mrs. Wheeler for relating to me before their death a number of reminiscences concerning the life of Dr. Lathrop. Professor H. A. Schuette of the Chemistry Department of the University of Wisconsin also kindly placed at my disposal material which he had collected on the life of Professor Lathrop. He published portions of this material some years ago in the Bulletin of the Chicago Section of the American Chemical Society in his series on the early days in the chemistry department at Wisconsin. (6) Dr. R. K. Richardson, Professor Emeritus of History at Beloit College, Historian of Beloit College, and formerly Secretary of the Faculty also made available to me the early minutes of the Faculty and official correspondence relating to Professor Lathrop.

I shall pass over briefly the early life of Professor Lathrop and stress in greater detail his contributions to the educational and agricultural life of the pioneer state.

Stephen Pearl Lathrop was born on a farm in Shelburne, Vermont, September 20, 1816. In spite of financial difficulties he worked his way through Middlebury College, graduating in 1839 and later receiving his master's degree from this institution. He first intended to enter the ministry but due to "a weakness of the lungs" he abandoned this purpose. He taught school for two years and then, in 1841, due to the interest which he had developed in science, turned his attention to the study of medicine. He received his M. D. degree in 1843 from the Medical College of Vermont at Woodstock. He successfully carried on the practice of medicine in Middlebury but his interest in science caused him to turn to teaching when a temporary vacancy occurred in the science department of Middlebury College due to the absence of the science professor in work on the State Geological Survey. Beginning in 1845 Dr. Lathrop also served the State as Assistant Geologist for several years. In addition to all this he became principal of the Female Seminary at Middlebury where he wrote in the circular advertising the school: "The usual rigid intellectual and moral discipline, which has been found successful and essential in establishing a high order of scholarship and a correct deportment will be adhered to, together with the same liberality in the employment of able and efficient teachers. It is intended that the Instruction and Education acquired in this institution, shall be such as to lead the pupils to think as well as to act. . . . Perfect punctuality and regularity in all the duties of the school is the standard. A vigilant attention is paid to the health, manners, and morals of the young ladies boarding in the Seminary. A Bathing-room is prepared especially for their use and the house-regulations require daily exercise in the open air. The school is opened and closed with proper religious exercises, and there is morning and evening worship in the family.

"The scholars are charged, per term of 14 weeks, for instruction in the common English studies, $3.50—for the higher English studies, $5.00. The following charges are extra—for Latin, $2.00—French and Drawing, each, $4.00—lessons on the piano, $10.00—use of instrument, $2.00. Board, including Fuel, Lights, and Washing, $30.00 per term. Board alone, $1.75 per week. Pupils are required to furnish themselves with Towels, Soap and Matches."

It was in 1848 that the Honorable Wm. Slade, ex-governor of Vermont, wrote to the Reverend Mr. Stephen Peet, the agent of the Trustees of Beloit College, calling his attention to the qualifications of Dr. Lathrop for the new chair of chemistry and natural science which was soon to be filled at Beloit College. "He has devoted much attention to Botany and has a large collection of plants which he would take with him," wrote Mr. Slade. "Also a large and well-arranged mineralogical cabinet. He is hearing recitations and delivering lectures in the College (besides his female school)." He was described as a man agreeable in manner, and of kind disposition, tall and commanding in form. He was a member of the Congregational church and superintendent of the Sabbath school in Middlebury. "His piety is stable, consistent and practical," continued the ex-governor. "He would make a very valuable professor in your college and a useful member of your community." Likewise in August of 1848, Dr. Labasse, the President of Middlebury, wrote the Reverend



S. P. Lathrop

Mr. Peet concerning Dr. Lathrop that "he had been urged to devote himself to the practice of medicine but his love for teaching forbids." The president regarded him as an excellent instructor and a man of high attainments in natural science. He further remarked that "Dr. Lathrop is a pretty decided, though not obnoxious abolitionist. This, I conclude, will not be regarded as a disqualification in your community." In August of that same year we find a letter from Dr. Lathrop to the Reverend Mr. Peet in which he says: "That I possess *all* the qualifications which you desire in a professor, I very much doubt. I feel competent, however, to instruct well those who may wish to pursue chemistry & Natural History. I lay no claim to great scholarship or extended literary research. There are many things of which I am very ignorant. I graduated in the fall of 1839, received my master's degree in course and was made Doctor of Medicine by the faculty of Vermont Medical College in 1843. Most of my time since then has been spent in teaching. Chemistry and the branches of Natural History are my favorite pursuits. In these I have made some advancement." In September, 1848, the faculty of Beloit College elected Professor Lathrop to the new chair and the call was extended to him by the trustees. The minutes of the Beloit faculty for September 19, 1848, record that "It was resolved that Dr. Lathrop be requested to spend a portion of the current year in raising funds and procuring apparatus for his department." On the 10th of November in that year, in reply to a letter from the Reverend Mr. Peet informing him of his appointment to the professorship of chemistry and natural science, Dr. Lathrop wrote: "The very favorable impression I have received of your enterprise strongly inclines me to a hearty acceptance of the appointment though it might not be considered judicious with my present knowledge of the conditions and prospects of your college, to give a decided answer in the affirmative.

"The professorship of chemistry and Natural History in any college, attended as it necessarily is with considerable expense in the procuring of proper apparatus and the obtaining and preserving of cabinets of specimens is very apt to fall under the censure of Trustees, unless they are truly of correct and liberal views regarding it. Chemistry and the various branches of Natural History, from their intimate connection with the arts and agriculture are becoming the most important, as well as useful and popular branches of a finished education. The estimate placed upon the professorship of chemistry etc. by a board of trustees is very important, therefore, to be known." He asks many questions regarding the college work, the cost of living, buildings and grounds, size of the town, ranges of the temperature, healthfulness of the region, of the state of Christian society, of the moral character of the community and state. "Did my present connection with the seminary here allow of it," he continues, "I should endeavor to make arrangements for visiting the several colleges in New England this winter and spending some time at New Haven or Cambridge in their chemical & agricultural departments. I may yet be able to accomplish it. Did my means allow it, I should certainly do so."

There were many delays before Dr. Lathrop finally accepted the offer from Beloit. In December of 1848, the Reverend Mr. Peet wrote that there was uncertainty as to the ability of the College to carry out the appointment and advising that the matter be allowed to rest for a time. In March of 1849, Dr. Lathrop again writes to the Reverend Mr. Peet and tells him of his efforts to become acquainted with Beloit and with the College and of the favorable word he has received and that "with the advice of friends have concluded to accept your appointment as Professor of Chemistry and Natural History in Beloit College." He inquires as to the status of reports proposing the establishment of a State Geological Survey in Wisconsin and also of an account of the proposed establishment of a university at Madison. He goes on to say: "A short time ago I received a communication from Professor Henry, Secretary of the Smithsonian Institute at Washington, wishing me to keep a Meteorological Journal at Beloit & also that further particulars should be sought with regard to the mounds in the State of Wisconsin.

"I would respectfully suggest the enquiry whether a Meteorological Journal might not be immediately commenced at the College (if it is not already) by one of the gentlemen there. It might be of much service for future reference.

"I suppose your College is entitled to a copy of the 'Contributions to Knowledge' lately published by the Institute & also to various Reports &c. They are of much scientific value."

There follows an exchange of telegrams which show an unexpected need for Dr. Lathrop at Beloit and his uncertainty in leaving his appointment at Middlebury. A letter to the Reverend Mr. Peet on the 16th of August, 1849, shows his willingness to arrange his affairs so as to enable him to come. It was his plan to leave his family in Middlebury and to operate the seminary under his name until spring but to hire a teacher to take his place. He intended to leave for Beloit in the fall but stated that he would prefer to return before navigation closed and have the winter to settle up his affairs and to collect apparatus for the College. In a letter about ten days later he writes that he has decided to take his family that fall. He asks help in hiring a convenient house and states: "I have a wife and two little boys, one of four and the other of two. The health of the younger is not good. I am in hopes that a change of climate & the journey may improve him. If they do not he will soon go into a decline. . . . I find that there are many & strong ties to be severed upon my leaving this place where I have enjoyed so much in the society of old and tried friends & in the kind embrace of my Alma Mater." He writes of preparing to leave with much uncertainty as to the wisdom of his choice and as to the reception he may expect in the West but with trust as to the future. The last letter in the series was written on the 25th of September and tells of a serious sickness which had prevented him from leaving for the West. It was his hope to be in Beloit about October 6th. He mentions his lack of apparatus and expresses the hope that the College will be able to buy "a small chemical apparatus." He asks the possibility of borrowing from the Academy at Platteville where he has read that they have "a good chemical apparatus."

It was not until after the opening of the fall term in 1849 that he was able to arrive in Beloit with his family, and then, much to his disappointment and concern, without the chemical and philosophical apparatus which he had hoped to bring with him. No mention is made of how the family traveled to Beloit. The journey and the change of climate failed to improve the health of his younger son who died the following March at the age of three. Tragedy seemed to follow this family. His first wife, Lucy Gibson Warner, who was born at Andover, Vt., December 15, 1823, and whom he married there on March 20, 1844, died of consumption in Middlebury on January 30, 1848. He married Martha Hemenway Clement at Topsham, Maine, on the 9th of April in 1849. Just over five years later she was left a widow with three small children. A daughter, Helen Hoyt, was born May 31, 1855, a short time after the father's death. She died of heart disease on the same date twenty-six years later. The other son who came West with the family enlisted in the Union army while still a student at Beloit College. The family bible contains only the notation,—"William P. Lathrop, born January 30, 1845. Missing during the battle of the Wilderness, May, 1864." Mrs. Lathrop died in LaCrosse, Wisconsin, May 30, 1909. She was survived by a daughter, Mary Bowditch (Mrs. W. H. Wheeler), who died in Beloit in 1935.

The family took up their residence near the campus. Beloit then had a population of about 2,000. The railroad had not yet arrived. The College consisted of one building, Middle College, and a faculty of five, including the newly appointed president, Aaron L. Chapin, and Professors Bushnell, Emerson, and Lathrop, and a tutor, a Mr. Carey. There were eight students in the college, but 50 were enrolled in the preparatory department and 144 in the seminary. The first college catalog with the announcements for the year 1849–50 states that instruction will be given in the department of natural science by recitation from the textbooks accompanied by theoretical and experimental lectures. In the third term of the junior year Gray's Botanical Text Book was taught, and in the first term of the senior year Edward's Physiology and Agassiz and Gould's Zoology. Silliman Jr.'s Chemistry was taught in the second term of the senior year and Dana's Mineralogy and Hitchcock's Geology in the third term. In addition to his work in the natural sciences Professor Lathrop had charge of the normal department. The facilities for teaching science were of course meagre. The first catalog states that arrangements had been made for procuring apparatus illustrating the departments of chemistry and natural philosophy to be ready for use at the beginning of the coming collegiate year. There was a library of 1,000 volumes. The mineralogical cabinet had received valuable accessions and illustrated most of the minerals and rocks of the United States. The catalog continues: "The liberality of different friends had furnished the institution a beautiful assortment of marine shells which with the collection of Professor Lathrop, which is deposited in the cabinet, makes up a conchological cabinet consisting of more than a thousand specimens. The botanical collection of Professor Lathrop which is also deposited in the cabinet embraces about 1500 varieties principally from foreign countries, besides which the collection of plants indigenous to the North West is considerable and is rapidly increasing." Later, the catalog of 1853 makes note of the fact that collections have been commenced by Professor Lathrop for the illustration of the ornithology, mammalogy and ichthyology of this region. It might be added here that in 1852, while still a member of the faculty, he donated these valuable personal collections to the College and for which, by vote of the faculty, he received their sincere thanks.

That Professor Lathrop was a man of many interests is shown by the breadth and variety of his activities. The first meteorological observations in Beloit were made by him during the year 1850. In addition to his duties in the College he continued the practice of medicine. He had rare common sense and a gift in the diagnosing of cases. He was said to be skilled as a surgeon and to have performed difficult operations on the eye. He must have been a good organizer with a large capacity for work and with a gift of getting things done. His early interest in agriculture continued in his new home. As a farmer himself, he cultivated a small tract on the outskirts of Beloit where he put into practice his own teachings in the field of scientific agriculture. He was noted for the raising of purebred poultry and stock. He was a regular exhibitor and prize-winner in these classes at the Rock County Fair which, by the way, he was instrumental in founding. He was active in the support of the State Fair where he served as a judge of various exhibits. He took an important part in the affairs of the newly organized Rock County Agricultural Society and Mechanic's Institute serving as vice-president in 1853 and as president in 1854. He also served on the committee to draft a charter for the Society. (1) In the proceedings of the Society for 1852 we find that at the annual meeting held in Janesville on December 1, 1851, "It was voted that Professor S. P. Lathrop of Beloit College be requested to read an essay before the Society at the next quarterly meeting." No record has been found of this essay, or of his presidential address which should have been delivered at the Rock County Fair in the fall of 1854. Perhaps the press of his new duties at the University of Wisconsin, where he had but recently arrived, or his absence in the East procuring equipment for his new department prevented this appearance. He was a member of a number of organizations including the State Medical Society and the Rock River Medical Society. Among his papers deposited in the Beloit College Library will be found his diplomas and his certificate of membership in the American Association for the Advancement of Science, signed by the permanent secretary, Spencer F. Baird, in the year 1853 when he was elected at the seventh meeting of the Association held at Cleveland in July of that year. He was deeply religious by nature and was a member and elder of the Presbyterian Church of Beloit. He was doubtless drawn to this group because of its early sympathy with the cause of abolition.

In 1853 we find him contributing a series of six papers on the Chemistry of Plants to the Wisconsin and Iowa Farmer. (7) In 1854 in the last year of his life he became a joint editor of this journal. It was undoubtedly due to the wide influence which he exerted among the farmers of the State that he received a call in the spring of 1854 to fill the new chair of chemistry and natural science at the University of Wisconsin. There had been an insistent demand through the columns of his journal for better provision on the part of the State for the education of the farmers, particularly in scientific agriculture. No one better fitted to the task could be found and no choice more acceptable to the farmers could be made. As Chancellor John Lathrop of the University wrote him on the 26th of March in that year: "Your letter of acceptance of the chair offered you in this institution came to hand. . . . I am satisfied you will have no cause to regret your translation to this position from which you will be better able to command success in the promotion of those valuable scientific objects to which your professional life stands pledged. . . . Shall expect you here about the 24th of May with such apparatus, chemical and philosophical, as you can command and will have occasion to use in your short course of instruction here this term.

"If our money shall hold out well, I do not despair of obtaining an additional appropriation in July for furnishing out your department more largely. . . .

"As you have had experience in creating your department at Beloit, we trust you will take hold of the same work here bravely. What you would have it, make it. We say this the more unreservedly because we are acquainted with your disposition to bring the department into sympathy with the farming interests of the State, as well as with the arts."

It was this rare gift of being able to carry his learning to the people in a language which they could understand and to inspire their trust and confidence that characterizes Professor Lathrop's work, and accounts along with his sound common sense and sterling integrity for his wide influence and for the high esteem in which he was held. His career at Madison was short. Before he had completed his first year at the University he was stricken with typhoid fever (2) and died on Christmas day, 1854, in his 39th year, at the very beginning of his work when he was just finding his true field in the service of agriculture in the new State. That he left an abiding influence on his friends and associates is shown by the testimonials of sympathy and esteem which poured in to comfort his bereaved family. Among the resolutions were those from the County and State Medical Societies, from the Rock County Agricultural Society and from the Faculty of the University of Wisconsin. Typical of these testimonials is the resolution adopted by the Rock County Agricultural Society and presented by the Hon. Josiah F. Willard* in which he says in part: "We most deeply deplore the loss of one whose honesty of purpose, gentlemanly deportment, and untiring zeal in the advancement of this society has so won upon our affections and entwined himself around our hearts. Resolved, That we shall ever hold in pleasing remembrance our intercourse with him and that his name and his memory are deeply enshrined in our hearts. . . ." President Chapin of Beloit College in his funeral sermon referred to him as a man of great practical

* Father of Frances E. Willard.

good sense, of sound judgment, earnest, unbending integrity and simple true-hearted piety. He was plain in manner and address but had a warm heart and commanded confidence and respect as a citizen.

We can best understand Professor Lathrop and evaluate his work and his contribution to his time by reviewing briefly some of his lectures and editorial work. These lectures* are laboriously written out in longhand. In most cases they are undated. Some certainly represent his classroom lectures and cover such topics as the Philosophy of Vision; Chemistry as Connected with Medical Philosophy; Pneumatics; The Atomic Doctrine; Animal Heat; and various others on education and subjects connected with his teaching. It is hoped that some of these may be edited at a later date. Others are evidently public addresses for he was often in demand as a speaker at various gatherings. One of these is an address delivered at an annual meeting of the Rock River Medical Society in which he pleads for common sense on the part of the people in their attitude toward sickness and in their relation to the medical profession, and for freedom from superstitions and the credulity which allows them to be the victim of quackery and fraud. He holds up high standards for the profession before his audience and asks them, "Is it too much to expect of the stable and well informed in the community that they will give their countenance to the objects at which we as a body of medical men aim? While we are struggling together in various ways to elevate the standard of the medical profession & to rid our noble and honorable calling of the abuses which impairs its fame & usefullness, we have a right to demand of the community a cheerful & active support in these efforts."

In an undated address entitled "Chemistry" which he delivered before the Rock County (?) Teachers' Institute which "has been holding its sessions for a few days past in this village" (place not named) he imparts to his audience some of his ideas on education, and of the value of science and of chemistry in particular in the education of the young. Some of his ideas are quite similar to those being advanced today and are well worth our consideration. Before taking up his main topic he indulges in some general remarks regarding education in which he says, "He who assumes the responsibilities of a teacher should endeavor to obtain liberal and enlightened views of his duty, which consists not wholly in teaching to spell, read, write and cipher. This province is more extensive and noble than this. It is his duty to expand the mind, to moralize the heart, to teach the

* Among the manuscripts and papers belonging to Professor Lathrop which were kindly furnished by his daughter, Mrs. W. H. Wheeler of Beloit.

breast to glow with the love of country and to prepare youth for *public* as well as *private* action.

"It is thus that our schools and colleges are to become the safeguards of our commonwealth and nation. . . . The duties of the instructor, no matter whether he pass by the dignified name of Professor or by the humble one of teacher are the same. . . . Let us then, my fellow teachers, cultivate in our breasts enlarged and just views of the studies to be pursued in our schools and the plans of instruction to be adopted.

"It becomes us then as teachers to enquire 'What is the education which we should promote?' . . . Education is the growth and improvement of the mind. Its great object is immediate or prospective happiness.

"That then is the best education which insures to the individual and to the world the greatest amount of permanent happiness, and that the best system, which most effectually accomplishes this grand design.

"By happiness is meant, not the effervescence of feeling which agitates a giddy mind, . . . but an inwoven, deeply-rooted enjoyment rising from the fountains where reason and philosophy, nature and art, combine and mingle all their sweets. . . . In that hard doom which bound man to daily toil for his subsistance on the hostile earth, we behold the tokens of mercy that by the constitution of his nature, he is able to convert all the objects around him into sources of pleasure. It is this capacity to see and enjoy beauties in the works of creation, that we would cultivate, making all things answer the double purpose of supplying our wants and administering to our enjoyment.

"It is a fact worthy of the attention of every instructor . . . that children and youth possess this faculty of seeing the beauties of creation and of delighting in them developed to a remarkable degree. I ought, perhaps, rather to say, that they possess this faculty intuitively. I might go farther and say that it is innate with them. For I believe that if they have received anything intellectually at the hand of God, their Maker, it is the power of readily seeing and thankfully admiring the beauty of arrangement and the happy adaptation of means to ends, which are so manifold and so manifest in Nature around us.

"And what is to be deplored by every enlightened teacher is that our system of instruction tends so much to smother and utterly stiffle [sic] in the breast of the pupil every latent principle of this kind which would, under more favorable circumstances, spring up and impart its vigor and life giving energy to the other more dormant faculties of the mind. This faculty, not stiffled [sic], but disciplined by a proper education, imparts to youth its purest and richest pleasures, and gives to middle age that calmness of mind, evenness of temper, so much to be desired, and finally, introduces a pleasant green old age, into which the buoyancy of youth is carried and the intellectual strength of manhood is preserved. It is too much a fault of our present mode of education that one of its results is to destroy the continuity of one's life and cut it up into fragments. . . . Suffice it to say, that in my opinion, nothing would more effectually and happily remedy the evil to which I have slightly alluded in these remarks, than the introduction into our schools of several of the more common branches of Natural History. The study of Botany, which gives us a knowledge of the great variety of flowers which adorn the surface of the earth, and of the forests so useful to man,—The study of Mineralogy which imparts a knowledge of the different rocks and metals . . .,—The Study of Geology which gives us a knowledge of the Earth's structure, and takes us back in time ere Adam was, or the morning stars sang together for joy,—The study of Birds, and Beasts, of Reptiles and Fishes, all the animals that have existed and do exist on the earth. It is the peculiar province of these several branches taught in a familiar, parent-like manner, to awaken the minds of children and youth to noble and just sentiments of virtue, honor and justice.

"They can but enlarge, elevate and purify the intellect. And what I am permitted on this occasion to say of chemistry, I would, had I the time and opportunity, say as fully of the several other branches of Natural History.

"To these branches of study there does not exist the objection which the question—What is their use?—so often put by many, implies.

"They are of great importance to all classes of our citizens. To the farmers, to the mechanic, to the professional man. Without some knowledge of them, the physician is hardly worth the title of his profession. If the members of the legal profession had been more familiar with some of these branches, their proceedings would not have been marked with so many inexcusible blunders. . . .

"Had the learning of our clergy extended a little more into the department of Natural History, we should be saved from witnessing such frequent ill-conceived views of Nature and her laws. Ecclesiastical ignorance of Nature unfortunately is not confined to the time of Galileo. . . ."

After this introduction which I think is of as great interest to us today as it was to those teachers of a century ago, Professor Lathrop takes up the subject of his address,—the importance of chemistry as a branch of education in our schools.

"And first," he continues, "to the Agriculturist, who derives, as a general fact, most of his education from our common schools,—the study of Chemistry is of great importance. It is true that in the present condition of our prairies, their abundunt fruitfulness, and the scarce population which occupy but a small portion of their surface,—a very defective system of culture will produce food enough, not only for the wants of the inhabitants, but for the partial supply of other countries also. But when our population becomes more dense, the same imperfect or sluggish system will no longer suffice.

"The land must be better tilled, its special qualities and defects must be studied, and means must be adopted, for extracting the maximum produce from every portion susceptible of cultivation. . . . From data easily obtained, I think the conclusion is safe, that unless some general improvement takes place in the agriculture of the country, the demand of the population will sooner or later completely overtake the productive powers of the land.

"The experience and the example of other countries, the Eastern portion of our own, encourage us to look forward to great improvements in the art of culture, and, independent of such as may be purely mechanical principles, theoretical Chemistry seems to point out the direction in which important advances of another kind may reasonably be anticipated. . . . The Chinese, who are the most distinguished for the perfection of their system of culture, are said to be not only familiar with the relative value and efficiency of the various manures, but also to understand how to prepare and apply without loss that which is best-fitted to stimulate and support each kind of plant.

"How far this is true, we are unable to determine, but it is in this direction that Chemistry appears likely and promises much to promote the advances of agriculture." It remained for Professor F. H. King of the College of Agriculture of the University of Wisconsin many years later to reveal the truth of this statement regarding the methods of Chinese agriculture in his well-known book, *Farmers of Forty Centuries.* (4)

"The practical farmer of the East," continues Professor Lathrop, "already rejoices in having one ton of bone dust the equivalent of fourteen tons of farm yard manure. Some of the most skillful chemists predict that methods will hereafter be discovered for compressing into a still less bulky form the substances required by plants, and that we shall live to see extensive manufacturies for the preparation of these condensed manures. . . ."

There follows next a discussion of the composition of the soil and the relation of the plant to it, similar to material which will be considered later in another connection. Here we plainly see the influence of Liebig's teachings and of others of his followers in this country. (5) "The rotation of crops," says Professor Lathrop, "is a practical rule, the benefits of which have been proved by experience: it becomes a true philosophical principle of action when we discover the causes from which this benefit springs. Botany has thrown considerable light of an interesting and important kind upon this practice, but Chemistry has fully cleared it up and established the principle.

"The art of Agriculture indeed is almost entirely a Chemical art since nearly all its processes are explained on chemical principles. . . .

"I might also show that the feeding of cattle, and the raising and management of dairy produce, are not beyond the province of chemistry, and that the only approach to scientific principles yet made, even in these branches of husbandry, is derived from chemical research. . . . How is a large portion of our agriculturists to acquire their knowledge, so essential to their interests, if Chemistry is not to be made a branch of study in our common schools, and if, which I hope will not be the case, our school teachers are unable to teach it?

"I am aware that there are some who will have it that the cultivation of the soil has no business with Chemical knowledge, and who maintain that dry rules or the customs of their fathers are enough to meet their wants. Passing by the moral disrespect implied in such an opinion, it will be enough to say, that the farmer is required, for the most part, to supply his own rules of thrift.

"There is no great fountain of wisdom and beneficience [sic] in the learned professions, in the other arts, or in the State, from whence the needed information may flow forth. On the contrary, the improvement must be made by those who want it,—by those who are to experience its greatest benefit. And when it is made, it will often be found not to consist in a few summary processes, so plain and easy as to secure universal success, but rather in a scroupulous [sic] attention to petty details, before over*looked*, but which are perceived to be of prime importance to the grand result.

"But further,—a knowledge of the principles of Chemistry is important to manufacturers, and the common laborers of all descriptions, rendering them more skillful in their respective professions and employments. . . . So essential is Chemical knowledge to the greatest success and profit of a manufacturing establishment, that many of them employ Chemists for the special purpose of directing this portion of the business, the perfection of which, so much depends on Chemical principles. . . . The operation of brewing fermented liquors is likewise a Chemical process. It may be thought that it would have been well for the human family had man remained ignorant of this process. But this is one of the evil branches of the tree of knowledge which has not been so faithfully guarded by a two-edged sword. . . ." There follows the story of the application of chemistry to a number of phases of our daily life. He frequently shows that he is a hater of any form of sham. He takes this opportunity to say: "A quack in the medical profession or in any other,—is one who pretends to a skill or knowledge which he does not possess, or, who practices upon principles of which he knows nothing and cares less.

"We have quack ministers, strange as it may be, and we have quack lawyers, which is not all strange, and what is the least strange of all, we have quack doctors. But are there no quacks among the farmers,—no quacks among our mechanics,—and, pardon me ladies,—are there no quacks among our housewives and their daughters?

"We have many good farmers, and many good mechanics and a greater number of good wives,—all who do well because they do just as their fathers and mothers did before them and who are as ignorant of the knowledge of the whys and wherefores of what they do as they are of a knowledge of Koran or Shaster.

"The custom of our fathers and the rules of the cook-book are all very well and *sometimes* produce very happy results, when the circumstances in the case are the same, but change these, and all is changed. . . ."

That the speaker was a vigorous exponent of a more thorough scientific training for the physician and surgeon is shown by the next portion of this address: "But the large mass of people suffer vastly more from their own ignorance of the commonest principles of chemistry," he goes on to say, "than they do from the ignorance of the physician or the apothecary. I think it may be affirmed with truth that a great proportion of the physical evils and accidents to which the human race is liable are the effects of a culpable ignorance, and might be prevented." To illustrate this point, he takes up the question of ventilation in relation to health, and referring to the frequent deaths from carbon monoxide poisoning from charcoal fires in closed rooms, he says, "The jury of inquest held on the following day gives it as 'death from charcoal vapors,'—but the Chemist who reads the verdict in some paper, translates it to,—'Death from ignorance of Chemistry.' For, had the victim, when at district school in youth, been blessed with the sight of a few experimental illustrations in Chemistry, he would have as soon have leaped into a well as have retired to sleep in a close apartment, warmed by an open furnace of charcoal."

". . . It might not be improper for me, did time allow, to speak of the manner in which Chemistry should be taught in our schools. It is frequently considered a difficult and dry study, but properly taught and illustrated by simple and easily performed experiments, which the good sense and wisdom of every competent teacher would dictate, it readily and certainly becomes one of the most interesting branches of study . . .

"Doubts have been entertained by some well-meaning persons as to the use of scientific enquiry. It has been thought needless, and some have gone so far as to think it even hurtful, filling us with a vain conceit of human learning, and dangerous to faith, which ought, they say, to be taken from God's *revealed* will only. Yet if ever a doubt should arise in the mind, as to whether what purports to be the *revealed* will of God,—be really so,—how are we to answer it? It can only be by the most scrutinizing investigations, that we can arrive at the certainty, that the Creator and the Law-giver are the same,—that certainty once attained, what doubt can then annoy us? And that certainty is attainable, for every step in true knowledge brings us nearer to the *Fountain of all Truth*. . . . The Chemist has given us some of the best lessons of the wisdom and benevolence of the Creator. . . . It is in the enlarged views that Science gives that we first learn duly to appreciate the Diety. Eternity, Infinity, Omnipotence, are attributes so astounding to human faculties, that we can arrive at the most moderate appreciation by steps. 'Jacob's ladder must stand upon the earth in order to reach to Heaven.' What more worthy employment, then, can man find for the faculties God has so richly bestowed upon him, than the investigation of those hidden forces which tell, in so plain a language, of the *Mighty Power* which called them into action? Before such knowledge superstition necessarily fades, like darkness before the sun. We may safely say, that no Chemist or Astronomer of the present age, could be an Atheist or Idolater.

"Let us not, then, underestimate the value of Science, for while it embraces our bodily comforts, it also elevates the mind to a state of more spiritualized feeling,—teaches us to dispise the low pleasures of Earth and strain forward toward that higher need which is alone worthy the aspirations of a human soul,—and whilst shedding blessings around us in this present world, gently leads us on to a better."

We must pass on now to the contributions of Professor Lathrop in the field of agriculture where he exerted his widest influence. A few excerpts from the History of Rock County and the Transactions of the Rock County Agricultural Society and Mechanic's Institute of 1856 will give us a background for an understanding of the agricultural practices and the condition of the farmers of the State as Professor Lathrop found them when he arrived in Wisconsin in 1849. Under the heading, "A Gloomy Time Among the Farmers of Rock County," compiled probably by the Secretary of the Agricultural Society, Mr. Guernsey, it states that: "This (1851) and the succeeding years were the gloomiest years of our agricultural history. . . . At this time agriculture in our county was in a very depressed state. Most of our farmers came West to raise wheat,—very little attention being paid to other crops. . . . The wheat crop, up to 1848, had been profitable, and as sure as any other, especially hedge-row; but this year commenced the blight,—rotting while standing in the field. Wheat during some of these years, was sold as low as 20 cents in Janesville; and carted to Milwaukee through the mud sold for 37½ cents. The price of corn was from 12½ to 15 cents; oats (9 cents) so low as to hardly pay the expense of threshing.

"The manner in which our farmers cultivate their land at this time cannot be better described than by quoting from a communication of James E. Burgess. esq. He says: 'A strict regard for truth compells me to say, that as a general thing it is rather slovenly. . . . First, they have attempted to cultivate too much land with very limited means; next, they have been deluded with the notion that wheat could be grown successfully for an indefinite period of time; that manuring, rotating crops, seeding down with timothy, clover, and other grasses . . . was altogether unnecessary. To surround a quarter section of land with a sod fence, break and sow it to wheat, harvest the crop and stack it; plow the stubble once and sow again with wheat; thresh the previous crop, and haul it to the "Lake," was considered good farming in Rock County'."

It was in part to improve such conditions as this that the Rock County Agricultural Society was founded in 1851. In the first address before the Society at the Rock County Fair in October of that year, the President, the Honorable Josiah P. Willard, remarked: "At no time in 50 years have the farmers had greater need of encouragement, as poor crops and low prices abunduntly prove." He made a strong plea for the education of the farmer and for the dissemination of scientific knowledge. Again in that same year, in an essay on "The Education of the Farmer" by the same author, this plea for the broader education of the farmer is continued. (3) In his presidential address at the annual fair in Janesville, October 6, 1853, Mr. Willard spoke the first encouraging words noted in these rather pessimistic accounts of the times. After remarking that "in the midst of abundunce we were poor,—dwelling in the very sunshine of nature's richest smiles, darkness brooded over our future," he went on to point out that the needed outlet to the markets of the world had arrived that year when the "iron horse" made its way across the prairies of Rock County. This opening of a market had its immediate effect and depression began to give way to prosperity. There still remained the same need for the education of the farmer and for the improvement in the conditions of his life and in his methods of agriculture.

It was on such scenes as those just decribed that Professor Lathrop looked as he came to this pioneer country. He sensed the needs of the people. He had the training and the practical knowledge needed and the gift for imparting to the people the facts of science as they applied to their daily life. Knowing his love of agriculture we can understand why he gave himself so devotedly to its cause.

In October of 1851 the Wisconsin and Iowa Farmer and Northwestern Cultivator moved its editorial headquarters from Racine to a more central location in Janesville. The editor, Mark Miller, must have seen in Professor Lathrop the very man he needed to aid him in his work. In July of 1853 Professor Lathrop began contributing to the Farmer with the series of articles on the chemistry of plants before referred to. In his introduction to this series he says: ". . . We will endeavor in a short series of articles on the Chemistry of Plants, to state some facts and make such suggestions as may be of service to the farmer. . . . It is to be hoped, then, that no one will be frightened with the heading of our subject, and pass it by because he has not studied chemistry. Please give us your attention and we will try to do you good. We have things to say most important to you if you desire to raise good crops of grass or grain, and at the same time, preserve the fertility and thereby, the value of your soil. The questions,—upon what does a plant live, from whence comes these materials and what is the effect of plants upon the soil on which they grow, and the air in which they live,—cannot but be of great importance to the farmer. These questions we will endeavor to answer in this series of articles and deduce from them some practical suggestions." He describes the constituents of plants which he arranges under the headings of organic and inorganic and discusses briefly the properties of each. He takes up the question of whence the plants obtain these constituents and shows "how greatly these inorganic constituents differ, not only in different plants but in even different parts of the same plant and also how greatly they vary at different seasons of the year in quantity and quality. . . . These facts are the bodies of true principles which should guide every agriculturist in the management of his soils." (7) The relation of crops to the soil is discussed and a comprehensive table "compiled from the most reliable sources within our reach" shows the pounds of each inorganic constituent carried off from the field for each ton or acre of crop. He remarks: "It is hoped that this table which has been prepared with much labor, will be found of much value to the farmer for reference, and that it may serve to guard him from robbing his fields of the elements necessary to their fertility. . . . That he may the more safely guard himself against a course of constant cropping without proper manuring or returning to the soil the peculiar ingredients which he removes in his crop, let him make an estimate of the weight of the several ingredients that he removes from his fields in his corn, oats, wheat, potatoes &c, and compare that with the weights of the same materials in the manure which he puts upon his fields. The table will suggest the reason of the injurious practice of the continued cultivation of the same kind of crop upon the same field." Sound advice follows as to the lessons taught from these facts but space does not permit further discussion here. With but few modifications, much of their teachings will be found in a modern book on agricultural chemistry. He concludes this series with the statement: "The several tables if duly considered, will enable the farmer to preserve the fertility of his soil at a comparatively less cost, and to adapt his crops to his fields by a suitable rotation of crops. He will be induced to return to his fields as much as possible of the same materials that he has removed by the carrying off of his crops. In fact all his operations may be carried out more understandingly, and he will feel a deeper and a more enlightened interest in the management of his farm." In the fifth paper of this series he asks the question: "How is this great amount of material, so essential in the formation of plants, to be restored to the soil?" He points out how "the agriculturist, unless guided by a proper consideration of natural laws, becomes a disturber of the balance of nature, though, happily, beyond a certain limit he cannot go. By constant cropping without manuring or returning in some form, the elements of crops to the soil, he greatly impoverishes his land, and beggars his successors in the ownership of the same." This whole paper would be well worth reading today, not only for its convincing style but for the truths which it contains. He truly states, "Our mother earth is a kind old mother, but of stern integrity. . . . But no where and at no time does she encourage slothfulness on the part of her sons, or inattention to her requirements." In answer to his question, he says, ". . . The art of reclaiming a worn out farm, or maintaining one in heart, depends, therefore, upon two considerations: First, a knowledge of the constituents of the crops to be raised—organic and inorganic. . . . And second, a knowledge of the ingredients of the soil, likewise organic and inorganic. . . . Till by some means, such as State patronage, or our own wealth, we are enabled to have an examination or a chemical analysis of our soils, we shall be oblidged [sic], of course, to be governed by general principles in the manuring of our land." As he concludes this series of papers, the author in characteristic manner says, ". . . We can but urge upon our farmers the importance of making themselves familiar with the principles of vegetable physiology, which includes not only the operations carried on in the plant itself but in all its relations to the world around it. Nothing would contribute more to the interest of agriculture and to the education of the agricultor, enobling both him and his pursuits."

With the beginning of the next volume of the Wisconsin and Iowa Farmer for 1854 we find the name of S. P. Lathrop joined with that of Mark Miller as editor and publisher. In a joint editorial the high aims of the paper are set forth, and the junior editor states among his interesting observations that "it will be the aim of the Farmer to bring the several branches of sciences to bear upon the processes of agriculture and the breeding of stock. We shall endeavor to assist the farmer in self-improvement. . . . Till lately, the farmers have been the hewers of wood and the drawers of water for every other class. . . . To render the agricultor and the artizan worthy of his own esteem and confidence and thereby of the regard of all others, will be one aim of the Wisconsin and Iowa Farmer."

With this volume appears a new column entitled "Domestic Economy." While this column is unsigned there seems to be good evidence from its style and content that it is from the pen of Professor Lathrop. Here is packed away much sound advice and good philosophy. The very spirit of the column seems to reflect the industry and thrift born of those rigorous years of boyhood training in the Vermont hills. It begins, "Regarding it of much importance to the farmer that everything pertaining to his farm be done in its season, we shall each month, call the attention of the farmer to 'what avails to be done' and we hope all will read and give heed." After the suggestions for January it advises, "Try to pay off all debts and begin the year with clean hands and a pure heart, owing no one anything but brotherly love and good will. Begin this year to keep accounts of expenses and incomes, with your farm, with your dairy, your hogs and your sheep, and with the merchant and the mechanic. Take a few or at least one of the best agricultural journals, purchase some agricultural books and study them all thoroughly during these long winter evenings." It advises reading aloud to the family as they work at their various tasks in the evening. "Then your minds and your hands will work together profitably. Intelligent farmers are destined to be thrifty farmers and they are happy farmers." It would be interesting to quote from this column from month to month to show the practical, common sense suggestions which it contains as in the June number when it says, ". . . and remember if it is dry weather, a good hoeing is equal to a small shower." And again in the September number: "We hope, too, that measures will be taken to secure the flouring of all our wheat in the State. We cannot afford to have anything carried out of the State that we so much need here for feed and for manure. Farmers should see to it that their wheat is floured at home, and that they have the coarse parts returned to them for feed, etc. It is to be remembered however, that much is lost in value to the farmer by carrying off all his produce and not feeding it out upon his farm." The farmer is urged to support the various fairs and to endeavor to profit by them and consider them as opportunities to learn and advance in their profession. Much of this advice resembles that which we might read today. "Resist the introduction of poor stock of any kind," it continues. "Every farmer should remember that it costs much more to feed stock and keep them in good condition if they are cold. Let all animals then, have warm and comfortable quarters." In the December number published in the last month of Professor Lathrop's life, this column again urges its readers "To see in time that the young animals are brought into comfortable winter quarters that they may be kept growing through the whole winter. Our cattle are not like trees in the vessels of whose tissues all circulation can cease during cold weather, and yet revive again in the spring, all uninjured. They are rather house plants requiring constant care that they may be kept from the winter's cold and the night's frost. The best and the most successful breaders [sic] of stock are they who take the best care of them." This advice to provide comfortable winter quarters for the cattle was undoubtedly occasioned because of the practice quite prevalent at that time of allowing them to winter on the open prairies.

We could not find a better note with which to bring to a close the quotations from this column than the following: "We must not forget to say a word about these long winter evenings,— charming times for social intercourse and general improvement. . . . Don't waste these good times lounging in the stores and taverns, or in foolish past-time and wicked games." Then with a good eye to business it concludes: "You had better put money in your own pocket and do your whole neighborhood a vast amount of real good, by getting up a large club of subscribers for the 'Farmer'."

The whole journal is packed with valuable information to the farmer and his household. No phase of his life is neglected. The need for his education is particularly stressed both editorially and by the contributors. There is evident a concerted movement to influence the State Legislature to provide for instruction in agriculture. A communication to the Wisconsin and Iowa Farmer from Solomon Lombard of Greenbush, Wisconsin, dated December 27, 1850, suggests "the establishment of an agricultural professorship in the University already founded by the State. Arrangements have already been made for the establishment of professorships of Law and Medicine. Let us have model farms, too, where young men can learn the art of cultivating the soil and by which they can render their homes upon the broad prairies and in the lofty forest, as much the abode of science, as the city homes of those who practice other professions." It is no surprise, then, to read the announcement in the columns of the Wisconsin and Iowa Farmer for June, 1854, that the junior editor, who had so soon made an important place for himself in the agricultural life of the State was severing his connections with Beloit College and taking up his residence in Madison, and to find in the September number among the advertisements the statement: "The first term of the next collegiate year of the State University will begin on the third Wednesday of September and a full course of instruction in Agricultural Science will be rendered during the first two terms by the Professor of Chemistry and Natural History, Dr. S. P. Lathrop, who is now East, selecting the apparatus needed to the department. We are certain that we can do the young farmers of Wisconsin no better service than to enjoin it upon them most heartily to prepare for the Agricultural profession by attending on the scientific instruction of the State University. We hope to hear of the entrance of a large class this coming fall." Incidentally the tuition was listed at $4.00 for the term, and private rooms, fuel, etc. at $3.00 for the term. No additional charges were to be made for contingencies. In the Editors Table for the August number, 1854, the program for the first commencement of the University is given with a few brief comments, and again reference is made to the new course in chemical and philosophical instruction to be given by Professor Lathrop, with special emphasis to be placed on the needs of the young farmer and mechanic.

We cannot refrain from quoting from a reference in this same number to the Beloit Commencement written most certainly by Professor Lathrop. "We had the pleasure, in common with many others, of being present at the exercises of this favorite and favored institution of the West, on the 12th ult. The exercises were of a very interesting character. The speaking was better than usual, with the usual exhibition of an high order of talent and culture. The *exquisites,* according to our palate, were, the Rev. M. Goodwin's Address of the evening previous; the salutatory by Page; the Valedictory by Brewster; and the Master's oration by Collie, of the class of '51. The prospects of the Institution, we understand, continue most flattering. Beloit College, we can ne'er forget thee. Some of our most earnest, sincere, and affectionate emotions have been exercised for thee; and thou hast and ever will have, a home in our regards.—May thou never prove barren, nor become the mother of ignoble offspring."

It is little wonder that in the obituary appearing in the Beloit Journal for December 28, 1854, his untimely death was spoken of as a "public calamity." His voice was one of the few as well as among the earliest in this country to spread the new teachings of science as applied to agriculture and to life. He was among the forerunners of that influential group who were to extend the teachings of Liebig far and wide, and who were to lay the foundations for the development of the modern agricultural research which we know today. (5) Had Professor Lathrop lived and continued through his teaching, speaking, and writing to spread his message throughout this region, it is hard to predict what far-reaching influence he might have had, and how much sooner the people of the State would have understood, accepted, and applied the knowledge upon which any sound and permanent system of agriculture must rest.

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NOTES ON WISCONSIN PARASITIC FUNGI. XVII

H. C. GREENE
Department of Botany, University of Wisconsin, Madison

The fungi referred to in this series of notes were, unless stated otherwise, collected during the season of 1951.

SYNCHYTRIUM AUREUM Schroet. has been reported as occurring on several kinds of violets in Wisconsin. Of a specimen on *Viola pallens* from near Mazomanie, Dane Co., May 22, 1947, M. T. Cook informs me that it cannot be *S. aureum,* but appears to him to be probably *S. globosum* Schroet. which occurs on species of *Viola* in Europe. J. J. Davis once, in the same locality, collected a specimen on *Viola* sp. which he doubtfully assigned to *S. globosum.*

MYCOSPHAERELLA sp. was noted on dead, brown areas of fronds of *Polypodium virginianum,* collected near Klevenville, Dane Co., July 1. A number of species of *Mycosphaerella* have been found on ferns, but this specimen matches none of the descriptions. The perithecia are only about 50–60μ diam., the asci 25 x 10μ, with very small ascospores, about 5 x 2μ. Parasitism doubtful, although large portions of the affected fronds were still green and living.

MYCOSPHAERELLA sp., of uncertain parasitism, occurred on withered, brown leaves of *Leptoloma cognatum* at Madison, September 5. Entire plants of this tuft-forming grass were affected, their stunted condition and poor color contrasting strongly with nearby healthy individuals. The numerous black perithecia are from subglobose to definitely flattened in shape, about 80–115 x 50–75μ. Some of the perithecia are beaked. The curved-clavate asci are 50–60 x 14–15μ, the hyaline, uniseptate, subcylindric ascospores 17–20 x 6.5–8μ. Accompanying the perithecia are occasional pycnidia which contain ellipsoid to subfusoid, hyaline, Macrophoma-type conidia, 17–22 x 4–6μ.

MYCOSPHAERELLA sp., parasitizing leaves of a scrub tree of *Pyrus malus,* was collected at Madison, August 2. Due to the large number of early and, all too frequently, inadequate descriptions of species within this genus, it is often difficult or practically impossible to ascertain whether or not one is dealing with a previously described species, and that is the case with this collection. The following notes were made: Spots faint roseate-grayish to cinereous, with narrow, dark, elevated margins on upper leaf surface—on lower surface, dull whitish to rufescent, sunken, mostly immarginate, but sometimes with a well-defined, raised, darker border. Spots usually numerous, well-defined and conspicous, rounded or variously orbicular, 1.5–5 mm., mostly 2–3 mm., diam. Perithecia amphigenous, but mostly epiphyllous, scattered or gregarious, black, subglobose, approx. 125–175μ diam.; asci hyaline, narrow-cylindric to subclavate, 45–65 x 10–13μ; ascospores hyaline, uniseptate, subcylindric to subfusoid, 13–16 x 5–6μ.

GNOMONIA sp. is in close association with *Marssonina quercina* (Wint.) Lentz on spots produced on still living leaves of *Quercus* (probably *Q. rubra*) collected at Madison, September 29. The perithecia have relatively short, thick beaks and are about 115–150μ diam. The asci are narrow-clavate, 30–45 x 6–7μ, the ascospores hyaline, uniseptate, narrow-fusoid, about 20 x 3μ, very uniform in shape and size. The long, slender spores do not match those of any other species described as occurring on *Quercus*. It seems to me highly probable that this is the perfect state of *Marssonina quercina.*

LEPTOSPHAERIA sp., very likely connected with *Stagonospora brachyelytri* Greene, occurs intimately associated with the latter in lesions on living leaves of *Brachyelytrum erectum,* collected near Darlington, Lafayette Co., July 30. The black, globose perithecia are about 175μ diam., the asci 75–85 x 11–13μ, the olivaceous ascospores 25–35 x 4–4.5μ and 8-septate. A peculiarity of the ascospores is that the third cell from the base of the spore (referenced to the base of the ascus) is nearly always nodulose-enlarged.

LEPTOSPHAERIA sp., in a possibly parasitic relationship, was collected on *Bromus inermis* at Madison, July 11. The spots are subelliptic to sublinear, about 2–4 mm. long, cinereous, with dark brown margins. The perithecia, from one to several per spot, are black, subglobose, about 150–160μ diam. The asci are clavate, 50–60 x 8–10μ. The dark-olivaceous ascospores are 3-septate, subfusoid, 17–19 x 4μ.

CHILONECTRIA CUCURBITULA (Tode) Sacc. has, until recently, been represented in the University of Wisconsin Herbarium exclusively by specimens of the perfect stage. However, in October, in eastern Vilas Co., J. R. Hansbrough collected on dead leaders of plantation trees of *Pinus resinosa* a delicate species of *Tubercularia* which I assume is connected with *Chilonectria,* although I have been unable to find anything in the literature to indicate this is the case. Like the perithecia, the sporodochia are macroscopically small, crowded, and bright red. Unlike the perithecia, the sporodochia appear as appressed-convolute rather than globose or collapsed-globose. The delicate, ramose conidiophores are about 20–25 x 1–1.5μ, the tiny, hyaline, rod-shaped conidia 3 x .7–1μ.

PUCCINIASTRUM PUSTULATUM (Pers.) Diet. I on *Abies balsamea* was reported by Davis in his "Provisional List of the Parasitic Fungi of Wisconsin", but before 1951 there was no Wisconsin specimen at the University of Wisconsin. In August, I. L. McMahon gathered good material near Sturgeon Bay, Door Co.

CINTRACTIA SUBINCLUSA (Körn.) Magn. was reported on *Carex lupulina* from Kenosha Co. on the basis of specimens taken many years ago near Racine. D. B. O. Savile has examined some of this material, including Fungi Columbiani 2615, and states that the host is *Carex lupuliformis* instead. Since achene characters seem to offer the only reasonably reliable means of determination, several specimens in the Wisconsin Herbarium were examined in the hope of finding some achenes still unmetamorphosed. In a specimen labeled as having been collected by J. J. Davis in Kenosha Co., August 14, 1904, such an achene was found and proved to be that of *Carex lupuliformis* as described, so Savile is correct, at least insofar as this specimen is concerned.

PHYLLOSTICTA sp., collected July 17 in a nursery at Madison, and appearing parasitic on leaves of *Celtis occidentalis,* is plainly not *P. celtidis* Ell. & Kell. The orbicular, dark-bordered tan spots are about 5 mm. diam., one or two per leaf. The thin-walled, subglobose pycnidia are approx. 100–175μ diam., the short-cylindric, hyaline conidia 4–6 x 2.5–3.5μ. Similar material was collected July 30 near Darlington, Lafayette Co.

ASTEROMELLA ANDREWSII Petr. in its ordinary conidial manifestation is common on certain species of gentian in Wisconsin. Leaves collected in September 1951 have, in addition to pycnidia bearing the usual globose conidia, other morphologically similar pycnidia producing rod-shaped hyaline microconidia, about 3–5 x 1.2μ, possibly the precursor of the subsequent *Mycosphaerella* stage.

ASCOCHYTA sp. on *Desmodium illinoense,* collected August 18 near Dekorra, Columbia Co., provides a puzzling problem, for the lesions on which it is borne are identical with those which I had assumed to be distinctive and characteristic for *Phyllosticta desmodii* Ell. & Ev. which has small conidia, on the order of 3.5–5 x 1.5–2.5μ. Those of the *Ascochyta* are about 11–13 x 3μ or even somewhat wider, and are in the range of *Ascochyta pisi* Lib., reported for Wisconsin on a number of other leguminous hosts. This latter fungus, however, when in good development, usually produces rounded, zonate spots, quite different from the angular, patchy lesions of the collection in question.

ASCOCHYTA sp., on spots which are thin, translucent and rounded, occurred on leaves of *Chrysanthemum balsamita* var. *tanacetoides* at Madison in July. The pale brown, subglobose pycnidia are about 125μ diam., and the subhyaline, short-cylindric conidia 5–7 x 3–3.5μ. This is quite different from another undetermined *Ascochyta* on the same host (Amer. Midl. Nat. 41: 715. 1949) which was on much better defined spots and had conidia 8–12 x 2.5–3μ.

STAGONOSPORA sp. was collected on *Verbena stricta* at Madison, June 28. The fungus is on spots of the type which are usually associated with so-called *Phyllosticta decidua* Ell. & Kell. The leaves are peppered with small, closely ranked, rounded, very thin translucent areas on which are borne rather large, thin-walled pycnidia, usually only one per spot. In this, and in other cases, the translucent spots suggest primary insect damage, but ordinarily there is none of the debris that so characteristically accompanies such infestations, so such origin is not certain. The parasitism of the fungi which occur on such spots is surely open to doubt, but since there is also doubt as to their saprophytism it seems proper to include them in these lists on a provisional basis.

Cirsium, Artemisia, and *Antennaria* in Wisconsin are frequently found bearing, on the wooly undersides of their leaves, setose perithecial or pycnidial fungi—more often the latter. The perithecia, so far as observed, are those of *Acanthostigma occidentale* (Ell. & Ev.) Sacc., and the amerosporous pycnidia sometimes associated with them, or sometimes alone, have been regarded as a stage of the *Acanthostigma.* However, in September 1951, on *Cirsium muticum,* there were setose pycnidia which contained 2–3-septate phragmospores, 13–23 x 2.5–3.5μ. While the amerosporous forms would be considered as belonging in the imperfect genus *Pyrenochaeta,* there seems to be no place in the existing classification for fungi with setose pycnidia bearing phragmospores. The pycnidia on *Cirsium muticum* are morphologically identical, although perhaps of slightly greater diameter, with previously collected amerosporous pycnidia.

SEPTORIA sp. occurred on the blackened tips of leaves of *Zigadenus elegans* on the Scuppernong Prairie near Eagle, Waukesha Co., June 2. The inconspicuous pycnidia are sooty, globose, about 100μ diam. The spores are hyaline, continuous, granular, mostly curved, but sometimes straight or slightly flexuous, rather thick in proportion to length, 10–30 x 2–2.5μ, ejected in slender cirrhi. I find no report of *Septoria* on *Zigadenus*.

SEPTORIA sp. occurs on, and seemingly is confined to, lesions of *Albugo bliti* on leaves of *Amaranthus retroflexus*, collected at Madison, August 15. The pycnidia are gregarious, dark brown, subglobose, 100–125μ diam. The spores are hyaline, slender, somewhat broader at the base, if septate very indistinctly so, from flexuous to strongly curved, 35–65 x 1.5–1.7μ. There seems to be no record of any *Septoria* on Amaranthaceae or on Albuginaceae.

SEPTORIA BACILLIGERA Wint. has been listed as occurring on *Ambrosia trifida* in Wisconsin, and a number of specimens so labeled, including several standard exsiccati, have been placed in the University of Wisconsin Herbarium. None of these corresponds with Winter's description (Jour. Mycol. 1: 122. 1885) which gives the spores as 9–23 x 3–3.5μ, and 1–3-septate, and would thus seem to refer to an organism in the *Stagonospora* category. For example, North American Fungi 2645 has spores 20–25 x 1.5μ, Fungi Columbiani 3383 has them 36–42 x 2.5–3μ and several Wisconsin specimens are as follows: 16–18 x 1–1.5μ, 30–33 x 2μ, 30–50 x 2μ, 16–27 x 1μ. It is scarcely possible to reconcile these with Winter's organism.

SEPTORIA sp. was found on *Ambrosia psilostachya* from near Dekorra, Columbia Co., August 18. In extreme spore dimensions, up to 110 x 3.5μ, this is far removed from *Septoria bacilligera* Wint. and from specimens which have been filed under that name, as will be seen by consulting the preceding note. On *A. psilostachya* the rather large black pycnidia are epiphyllous and clustered on irregular brown spots, the smaller and newer of which have angular, ashen areas on which the pycnidia occur. The spores are multi-septate, usually strongly curved, subobtuse at one end, tapered at the other, with many from 70–80 x 3μ and, as noted, up to 110 x 3.5μ. If additional equally well-marked specimens can be collected on this host, the conclusion that this is distinct may perhaps be justified. *Septoria ambrosicola* Speg. is described as having spores 50–100 x 1.5–2μ, similar to the Wisconsin specimen in length, but much narrower.

CYLINDROSPORIUM BETULAE J. J. Davis has not yet been connected with a perfect stage, but the existence of it is indicated in a specimen on *Betula papyrifera*, collected by E. M. Gilbert in September at Brule, Douglas Co. On the old *Cylindrosporium* spots there are scattered large, amphigenous, black, non-rostrate, depressed, immature perithecia which probably require overwintering for full development.

BOTRYTIS sp., a large, coarse form with conidiophore branches torulose, is hypophyllous on large rounded, grayish-brown lesions on leaves of *Sanguinaria canadensis*, collected June 27 near Milford, Jefferson Co. Like other infections of *Botrytis* observed during the cool, wet summers of 1949, 1950 and 1951 this appears to have been at least weakly parasitic, for the spots although very large, are sharply defined.

CLADOSPORIUM sp. is present and seemingly parasitic on plants of *Polygala verticillata* collected at Madison, October 3, 1951. In 1950 plants of this species at the same station were found heavily parasitized by *Curvularia lunata* (Wakker) Boedijn. The *Cladosporium* has conidiophores which are closely tufted, clear brown, straight to slightly curved, simple or once geniculate, 0–5-septate, approx. 50–100 x 5μ. The conidia are dilute gray, smooth, continuous or 1-septate, subcylindric or subfusoid, with prominent spore scars and appearing to have been catenulate, 14–20 x 4–5μ. Accompanying the usual *Cladosporium*-type conidia are short, broadly ellipsoid to limoniform conidia, a feature which is characteristic of certain other species of *Cladosporium.*

CLADOSPORIUM sp., which may be parasitic, was collected at Madison, June 20, on large, pale-brown, wedge-shaped areas on the leaves of *Symphoricarpos occidentalis.* Within the large spots the fungus is amphigenous on sharply delimited angular areas (vein islets). The conidiophores are scattered, or in tufts of not more than ten. They are almost straight, multiseptate, usually with several inconspicuous geniculations near the tip, which is paler than the lower chestnut-brown portion. Phores measured are from 65–160 x 4.5–6.5μ. The conidia are 1-septate, dark-olivaceous, markedly asperate, 13–20 x 4–7μ. There seem to be no reports of *Cladosporium* on *Symphoricarpos.*

ALTERNARIA HERCULEA (Ell. & Mart.) Elliott has been reported on *Brassica nigra* in Wisconsin and, if one follows Weimer (Jour. Agr. Res. 33: 645. 1926) in considering *A. herculea* as distinct from *A. brassicae* (Berk.) Sacc., a collection on *Brassica arvensis* made at Madison in 1951, with conidia 200μ or more, must undoubtedly be referred to *A. herculea.* However, other specimens are not so well-marked, and I believe the current tendency of plant pathologists is to consider these species as not distinct from one another.

TUBERCULINA (?) sp. occurred on living leaves and stems of *Desmodium illinoense,* collected August 20 near Delavan, Walworth Co. Viewed from above, the green host leaves appear to bear pulvinate gray-black sporodochia. In section, however, the layer of fungal tissue is seen to be relatively thin and the subbullate aspect of the lesions appears to be due in large measure to hypertrophy of the host. The sporodochia, as I nevertheless interpret them to be, are amphigenous, sordid whitish when young, later becoming grayish-black with the development of a compact layer of sooty conidiophores, at least some of which appear ramose. In outline the sporodochia are rounded, somewhat angled, or tend to be nervisequous, are often slightly convolute on the leaves, less so on the stems where the lesions are also more elongate and sometimes confluent. On the leaves the sporodochia are mostly about 1 mm. or somewhat less in diam., usually numerous, scattered to crowded, not on spots. The conidia are hyaline, ovoid or ellipsoid, 2.5–3.5 x 4–6μ, smaller than those of most species of *Tuberculina* which have been described. Another collection of a possibly related fungus was made at about the same time on living leaves and stems of this same host at a station in Lafayette Co., near Platteville. In the latter case, what appears to be a less well-marked development of the fungus described above has been overrun by a coarse, conspicuous species of *Cladosporium*. The picture is further complicated by the presence of *Ramularia desmodii* Cooke, and from the material at hand it would not be possible to assert there is no connection between the *Ramularia* and the presumed *Tuberculina*, although in the specimen from Delavan there is no evidence whatsoever of earlier *Ramularia* infection.

Additional Hosts

The following hosts have not been previously recorded in these lists as bearing the fungi mentioned in Wisconsin.

UNCINULA CIRCINATA Cke. & Peck on *Acer spicatum*. Door Co., Cave Point 4 mi. south of Jacksonport, September 9. Coll. I. L. McMahon.

MICROSPHAERA DIFFUSA Cke. & Peck on *Desmodium bracteosum* var. *longifolium*. Green Co., New Glarus Woods, October 6.

ERYSIPHE CICHORACEARUM DC. on *Aster ericoides*. Dane Co., Madison, October 9.

PHYLLACHORA VULGATA Theiss. & Syd. on *Muhlenbergia glomerata*. Door Co., Bailey's Harbor, September 24, 1932. On a phanerogamic specimen in the University of Wisconsin Herbarium.

PUCCINIA CARICIS (Schum.) Schroet. ii, III on *Carex flava* var. *fertilis (C. cryptolepis)*. Door Co., Fish Creek, October 19, 1920. Coll. and det. J. J. Davis, who collected a correctly determined phanerogamic specimen at the same time, but who failed to include this *Carex* as a Wisconsin host, perhaps because he did not find uredospores which are, however, present and characteristic, although in very small numbers. An earlier report of *P. caricis* on *Carex flava* var. *elatior (C. lepidocarpa* according to current treatment) should probably be deleted, since it appears this plant does not occur in Wisconsin, so far as now known.

CERATOBASIDIUM ANCEPS (Bres. & Syd.) Jacks. on *Cornus canadensis*. Door Co., Sturgeon Bay, July 7. Coll. E. H. Varney.

PHYLLOSTICTA FRAGARICOLA Desm. & Rob. on *Potentilla recta*. Waukesha Co., Kettle Moraine State Forest Ranger Station near Eagle, July 26. Very similar to earlier material on *Potentilla arguta* assigned to this species.

ASTEROMELLA ANDREWSII Petr. on *Gentiana saponaria*. Green Co., Exeter, September 19.

ASCOCHYTA COMPOSITARUM J. J. Davis on ray flowers of *Heliopsis scabra*. Dane Co., Madison, August 8. Referred here with some doubt. This is the small-spored form which Davis (Trans. Wis. Acad. Sci. 19(2): 700. 1919) originally set aside as var. *parva*, but later included with the species since he felt there was an intergrading series. So far as noted, none of the leaves of the host *Heliopsis* plants were infected.

STAGONOSPORA CONVOLVULI Dearn. & House on *Convolvulus arvensis*. Dane Co., Madison, June 28. Placed under *Stagonospora* because the pycnidia are perfect above with well-defined ostioles. That *Stagonospora convolvuli* and *Septogloeum convolvuli* Ell. & Ev. are really distinct from one another may be doubted. They probably represent the extremes of a series.

SEPTORIA AGROPYRINA Lobik on *Elymus virginicus*. Pepin Co., Durand, July 13, 1923. Coll. J. J. Davis, and filed as *Septoria* sp.

SEPTORIA ELYMI Ell. & Ev. on *Agropyron repens*. Dane Co., Madison, July 17. Only the name is new. Previous specimens were placed under *Septoria agropyri* Ell. & Ev. which Sprague states is a synonym.

SEPTORIA ANEMONES Desm. on *Anemone canadensis*. Iowa Co., Canyon Park near Dodgeville, July 15. Also found at stations in Columbia and Sauk Cos.

SELENOPHOMA EVERHARTII (Sacc. & Syd.) Sprague & Johns. on *Hystrix patula*. Green Co., New Glarus Woods, August 23, 1949.

PHAEOSEPTORIA FESTUCAE var. MUHLENBERGIAE R. Sprague on *Elymus canadensis*. Dane Co., Madison, August 12. Associated with char spot and *Phyllachora*, so perhaps not parasitic.

CERCOSPORA RIBIS Earle on *Ribes cynosbati*. Grant Co. near Platteville, July 30.

ADDITIONAL SPECIES

The fungi mentioned have not been previously reported as occurring in Wisconsin.

CALICIUM TIGILLARE (B. & Br.) Sacc. on *Polystictus pergamenus*. Waupaca Co., Symco, August 17. Coll. C. F. Pierson.

NEOCOSMOSPORA VASINFECTA (Atk.) E. R. Smith has been isolated in culture from roots of morbid clover plants from Wisconsin sources. Typical perithecia, with mature asci and ascospores were developed. Pathogenicity is so far uncertain, but it will be most interesting if the organism causing wilt of cotton and okra in the South is proved to produce the same effect on a leguminous crop in Wisconsin.

ARMILLARIA MELLEA (Vahl) Quel. on *Pinus resinosa*. Field and experimental studies conducted by R. F. Patton of the University of Wisconsin Department of Plant Pathology on plantation trees at Wisconsin Rapids and elsewhere show that *A. mellea* may act as more than a wound parasite and attacks the host through the unbroken tissue of the crown. This species has not been included in these lists before because of considerable doubt as to its active parasitism.

PHYLLOSTICTA DULCAMARAE Sacc. on *Solanum dulcamara*. Door Co., Sturgeon Bay, September 2. Coll. E. H. Varney. The pycnidia are somewhat larger than the 80–90μ of the description, but the specimen corresponds closely to Krieger's Fungi saxonici 1943, issued as *Phyllosticta dulcamarae,* so is referred to that species.

ASCOCHYTA VERATRI Cav. on *Zigadenus elegans*. Waukesha Co., Scuppernong Prairie near Eagle, June 13. On *Zigadenus* the fungus occurs on the blackened leaf tips. There is close correspondence microscopically with Kabat and Bubak's 262 of their Fungi imperfecti exsiccati, issued as *A. veratri* on leaves of *Veratrum lobelianum*. *A. veratrina* Ell. & Ev. has much larger pycnidia and smaller spores.

ASCOCHYTA VIBURNI (Roun.) Sacc. on *Viburnum opulus* (cult.). Dane Co., Madison, October 5. This specimen shows almost exact correspondence with European collections on the same host.

SEPTORIA CARICINA Brun. on *Carex sprengelii*. Dane Co., Madison, September 23. Described as with spores 32–35 x 1–1.5μ, a very narrow range. The Wisconsin specimen has them mostly 30–45 x 1–1.5μ. The pycnidia are minute, not over 65μ diam., and many smaller.

Phleospora panici sp. nov.

Pycnidiis hypophyllis, sparsis, late apertis imperfectisque supra, clausis infra, subglobosis, 85–115μ diam., muris tenuibus, pallido-brunneis; conidiophoris hyalinis, brevibus, angustis, 10 x 2μ ca., in ordinibus compactis; conidiis hyalinis, curvis maxime, multiseptatis indistinctis, 55–75 x 1.5–2μ.

Pycnidia hypophyllous, scattered, widely open and imperfect above, but entire below, subglobose in outline, 85–115μ diam., wall thin, pale brown; conidiophores hyaline, short, narrow, about 10 x 2μ, in compact layer over inner surface of pycnidium; conidia hyaline, very strongly curved, indistinctly multiseptate, 55–75 x 1.5–2μ.

On living leaves of *Panicum praecocius*. Chicago & Northwestern Railroad right-of-way in Lafayette Co., three miles southeast of Platteville, Wisconsin, U. S. A., August 4, 1951. Also on *Panicum scribnerianum* collected June 30, 1942, in section 2, Town of Troy, Walworth Co., Wis. and tentatively reported at that time (Trans. Wis. Acad. Sci. 35: 116. 1944) as *Septoria* sp. indet. Re-examination of the material, however, shows it to be very similar to the type on *P. praecocius*, differing materially only in having some pycnidia of greater diameter, up to 150μ or slightly more.

Dried pale-flesh-colored, globular masses of spores mark the position of the flaring pycnidia which are so deeply seated as to touch on both lower and upper epidermis without, however, causing any external distortion or discoloration of the leaf. Associated with the *Phleospora*, in the case of both host species, are numerous shining black, depressed, subapplanate bodies, approx. 175–250μ diam., which appear to be immature perithecia and which, in the field, were thought to be ascomata of *Phyllachora puncta*. Comparison with authentic material of the latter species, however, shows that the two are quite different.

Phleospora is considered by some to be an untenable genus, and the species have been reassigned to *Septoria* or to *Cylindrosporium*, but it seems to me that, pending final taxonomic placement of the fungi now thereunder, *Phleospora* is a useful form genus which should be retained.

GLOEOSPORIUM CHAMAEDAPHNIS Dearn. on *Chamaedaphne calyculata*. Door Co., Sturgeon Bay, September 2. A very clean-cut species, closely corresponding to the description.

FUSIDIUM PARASITICUM Westd. on *Xylaria oxyacanthae*. Dane Co., Madison, June 1951. Coll. and det. M. P. Backus and E. A. Stowell.

Cladosporium stipae sp. nov.

In foliis, maculis nullis vel indistinctis; conidiophoris solitariis, sparsis, ex subhyalinis, decumbentibus, superficialibus hyphis, claro-brunneis, subacuminatis, subgeniculatis, fere rectis vel curvis leviter vel flexuis, cicatricibus prope apicibus, 80–135 x 4–6μ, 3–6-septatis; conidiis continuis plerumque, raro uniseptatis, subfusoideis pallido-flavis, levibus, cicatricibus prominentibus, 17–20 x 3.5–5μ.

On leaves, spots none or indistinct; conidiophores solitary, scattered, arising from subhyaline, decumbent, superficial mycelium, clear brown, subacuminate, subgeniculate, from almost straight to slightly curved or flexuous, spore scars in cluster near tip, 80–135 x 4–6μ, 3–6-septate; conidia mostly continuous, rarely uniseptate, subfusoid, pale yellowish, smooth with prominent scar, 17–20 x 3.5–5μ.

On living leaves of *Stipa spartea*. Madison, Dane County, Wisconsin, U. S. A., September 6, 1951.

Very inconspicuous and chiefly detectable by the dull discoloration of sections of the leaves. The fungus is confined to the inrolling, strongly ribbed side of the leaf. The conidiophore has a characteristic "foot-cell" in the shape of an inverted T.

CERCOSPORA ATRO-MARGINALIS Atk. on *Solanum nigrum*. Dane Co., Madison, October 15. Det. Chas. Chupp.

HELMINTHOSPORIUM GIGANTEUM Heald & Wolf on *Panicum capillare*. Dane Co., Mazomanie, August 16. This collection would seem to provide a decided extension of the hitherto recognized range, as Sprague states that it is primarily a disease of the southern states, up to now being found northward only as far as Maryland and Pennsylvania. He reports *H. giganteum* on the closely related *Panicum dichotomiflorum,* but not on *P. capillare.* The very characteristic "eye-spot" lesions seem constant, whatever the host.

Coremium triostei sp. nov.

Maculis sparsis, paucis, parvis, plerumque circulis vel orbicularibus, interdum angulosis, 1–2 mm. diam. ca.; supra cinereis vel pallido-brunneis, marginibus angustis, fuscis, infra pallidioribus, depressis; coremiis gregariis, hypophyllis, hyalinis, hyphis adpressis vel intertextis laxe, interdum solitariis, erectis vel suberectis—hyphis solitariis saepe pilis ascendentibus—continuis, 2.5–3μ diam., usuque .3 mm. longis; conidiophoris rudibus, brevibus, rectis, lateralibus; conidiis catenulatis, hyalinis, fusoideis vel subfusoideis, 5–10 x 2.5–3μ.

Spots scattered, few per leaf, small, mostly round or orbicular, occasionally angled, approx. 1–2 mm. diam.; cinereous to pale brown above with narrow dark borders, paler below and somewhat sunken; coremia gregarious, hypophyllous, hyaline, weakly organized, with the component hyphae loosely appressed or wound about one another, or occasionally single, erect or suberect—often ascending the host trichomes when single—continuous, 2.5–3μ diam., up to .3 mm. long; conidiophores rudimentary, short, straight, lateral; conidia catenulate, hyaline, fusoid or subfusoid, 5–10 x 2.5–3μ.

On living leaves of *Triosteum perfoliatum*. Grant County, near Platteville, Wisconsin, U. S. A., July 30, 1951.

A snow-white, very delicate species. As indicated in the description, the coremia are loosely organized, but the best-developed are erect, and from their upper portions the conidial chains diverge in widely spreading fashion. In the same season another specimen was taken on the same host in the New Glarus Woods, Green Co. In July 1925 the late J. J. Davis collected a large specimen of this fungus on *Triosteum aurantiacum* at Spring Valley, Pierce Co., but he did nothing further with it and the collection was recently found in undetermined material left by him.

THE MEMBRACIDAE OF WISCONSIN

CLIFFORD J. DENNIS
Department of Entomology, University of Wisconsin

The Wisconsin species of Membracidae are active and abundant insects. The majority of species are tree-inhabiting, preferring oak. For this reason the Membracids are commonly called tree-hoppers. Some species, however, prefer herbaceous growth and shrubs. Most of the oak species have been collected in the southern two-thirds of the state, but they no doubt range farther north although probably not as abundantly. The herb and shrub inhabiting forms have been taken throughout the state. Seventy-five species have been collected in Wisconsin.

This paper includes keys for the identification of Wisconsin adult forms and a list of plants and traps which have yielded tree-hoppers. An effort has been made to construct easily workable keys to both sexes. Prominent characters have been used whenever possible, and most of these characters are illustrated. Measurements given are overall. In certain cases genital characters are necessary for determinations. Genitalia are prepared by treating the entire abdomen with 10% potassium hydroxide to remove the soft parts. The abdomen should next be washed and then stored with a drop of glycerine in a corked 4 x 10 mm. vial on the pin with the insect. Dissections may be made on a spot plate under glycerine. The terminology employed for the male genital parts used in the keys is that used by Funkhouser (1917). Valvula 2 of the female is the second valvula of Snodgrass (1935).

Aside from the exceptions which are given, Funkhouser's (1927) catalogue contains all pertinent literature citations.

Most of the records included are the results of the author's collections. Additional records were obtained from the collections of W. S. Marshall (by permission of S. Kramer), W. McNeel Jr. and R. D. Shenefelt, the Department of Entomology of the University of Wisconsin and the Milwaukee Public Museum (by permission of K. MacArthur). A few records for Wisconsin were found in the writings of Ball (1931), Funkhouser (1927), Van Duzee (1917) and Caldwell (1949).

The author is grateful for the encouragement and advice of many people received during the preparation of this paper, especially to Drs. R. J. Dicke, C. L. Fluke, J. T. Medler and R. D. Shenefelt of the Department of Entomology of the University of Wisconsin.

KEY[1] TO SUBFAMILIES OF WISCONSIN MEMBRACIDAE

1. Scutellum distinct, apex with two spines .... Centrotinae
   Scutellum concealed by the pronotum 2
2. Tibiae of first two pairs of legs foliaceous (II, 1)[2], tibiae of third pair of legs simple .... Membracinae
   Tibiae of all three pairs of legs simple .... Smiliinae

SUBFAMILY MEMBRACINAE (STAL)

KEY TO WISCONSIN SPECIES

Clypeus longer than broad, rounded at apex; pronotum with two yellow spots behind horn (II, 2) .... *Enchenopa binotata* (Say)
Clypeus not as long as broad, broadly truncate at apex; pronotum without yellow spots (II, 3) .... *Campylenchia latipes* (Say)

SUBFAMILY CENTROTINAE (SPINOLA)

A single species of this subfamily is present in the fauna of Wisconsin. It is *Microcentrus caryae* (Fitch) (II, 4).

SUBFAMILY SMILIINAE (STAL)

KEY TO WISCONSIN TRIBES

1. Elytra entirely free and uncovered by pronotum .... Ceresini
   Most or all of clavus and often part of corium covered by pronotum... 2
2. Hind wing with terminal cell usually sessile, its base truncated, rarely with terminal cell an elongate triangle with a short petiole .... Telamonini
   Hind wing with terminal cell a petiolate, equal-sided triangle 3
3. Base of corium with two longitudinal veins contiguous at their bases .... Polyglyptini
   Base of corium with three longitudinal veins, usually contiguous at their bases .... Smiliini

TRIBE POLYGLYPTINI GODING

KEY TO WISCONSIN GENERA

1. Pronotum neither elevated nor rugose; elytra with terminal cell transverse .... *Vanduzea*
   Pronotum elevated and rugose; elytra with terminal cell triangular... 2
2. Pronotum strongly elevated and with a deep median notch; aedeagus with posterior arm having a pair of superior lobes (I, 14) ..... *Entylia*
   Pronotum slightly elevated and slightly depressed before the middle; aedeagus with posterior arm having a pair of large lateral teeth near the apex (I, 15) .... *Pubilia*

[1] For the most part, keys in this paper are original, but in some cases those of Ball (1931), Van Duzee (1908) and Caldwell (1949) were drawn upon.

[2] Numbers in parentheses, such as (II, 1), refer to plate and figure numbers respectively.

Genus *Entylia* Germar

Entylia bactriana Germar (II, 5) is the only Wisconsin representative of this genus.

Genus *Pubilia* Stal

The single species of this genus found in Wisconsin is *Pubilia concava* (Say) (II, 6).

Genus *Vanduzea* Goding

KEY TO WISCONSIN SPECIES

Females

Larger (5.6–6.1 mm) (II, 7) .... *arquata* (Say)
Smaller (4.2–4.8 mm) (II, 8) .... *triguttata* (Burmeister)

Males

Larger (4.3–4.9 mm); tergite IX with oblique transverse carina not reaching the middle of posterior margin (I, 17); connective rounded posteriorly (I, 19) .... *arquata* (Say)
Smaller (3.6–3.9 mm); tergite IX with oblique transverse carina extending to below middle of posterior margin (I, 18); connective acute posteriorly (I, 20) .... *triguttata* (Burmeister)

TRIBE SMILIINI GODING

KEY TO WISCONSIN GENERA

1. Corium without cross vein connecting the two inner longitudinal veins .... *Smilia*
   Corium with cross vein connecting the two inner longitudinal veins... 2
2. Pronotum with dorsum regularly rounded, not at all compressed or elevated .... *Ophiderma*
   Pronotum with dorsum compressed, usually moderately elevated, may be strongly elevated.. 3
3. Connective with a small median protuberance on the incurved anterior margin (I, 16); pronotum moderately inflated before and behind mid-dorsal foveae.............................. *Xantholobus*
   Connective without a median protuberance on the incurved anterior margin; pronotum very slightly or not at all inflated...... *Cyrtolobus*

Genus *Cyrtolobus* Goding

The species of this genus are very difficult to delimit. They typically are marked with light oblique vittae, a mid-dorsal spot and an anteapical vitta. Much gradation exists in shape, coloring and genital morphology between what are considered to be species.

The genus or subgenus *Atymna* is considered synonymous with *Cyrtolobus* in this paper. The character used in the separation of it from *Cyrtolobus*, the crest of the pronotum highest before the middle, is very difficult to determine.

KEYS TO WISCONSIN SPECIES

Females

1. Pronotum green, without anterior oblique or anteapical vittae....... 2
   Pronotum not as above.. 4
2. Smaller (5.3–5.8 mm) (II, 16) .... *inermis* (Emmons)
   Larger (6.5–7.4 mm).. 3

3. Pronotum concolorous green (II, 17) .... *querci* (Fitch)
   Pronotum with dorsal carina broadly creamy white with central interrupted black line in posterior 2/3 (II, 15) ..... *helena* Woodruff
4. Elytra with prominent dark band across the middle (II, 19) .... *pallidifrontis* (Emmons)
   Elytra without prominent dark band across the middle 5
5. Smaller (4.8–5.0 mm) (II, 21) .... *puritanus* Woodruff
   Larger (5.9 mm or longer) 6
6. Larger (8.4 mm or longer); pronotum abruptly elevated behind humeral angles (II, 22) .... *tuberosus* (Fairmaire)
   Smaller (7.7 mm or shorter); pronotum not as above 7
7. Larger (7.4–7.7 mm); pronotum without anterior oblique vitta (II, 9) .... *arcuatus* (Emmons)
   Smaller (7.0 mm or shorter); pronotum with anterior oblique vitta.. 8
8. Pronotum deep reddish brown with a prominent mid-dorsal spot; pronotum tapering to the apex which attains, or almost attains, tip of elytra (II, 11) .... *fenestratus* (Fitch)
   Pronotum not as above 9
9. Pronotum pale yellow green, vittae obsolete, metopidium showing gradations from no spotting through a dark spot on each side to being almost entirely dark (II, 18) .... *maculifrontis* (Emmons)
   Pronotum not as above 10
10. Pronotum with anteapical vitta 11
    Pronotum without anteapical vitta 15
11. Elytra almost wholly reddish-brown (II, 13) .... *fuscipennis* Van Duzee
    Elytra not as above 12
12. Pronotum gray before the anterior oblique vitta, gray to reddish behind (II, 14) .... *griseus* Van Duzee
    Pronotum not as above 13
13. Pronotum with anterior oblique vitta and anteapical vitta approaching (often confluent) at margin of pronotum, a prominent brownish "V" formed between them and mid-dorsal spot (II, 23) .... *vau* (Say)
    Pronotum not as above 14
14. Pronotum low, ground color before anterior oblique vitta light testaceous (II, 20) .... *pulchellus* Woodruff
    Pronotum highly arched, pale brown, metopidium often with black mottling, anterior oblique vitta bordered narrowly with reddish before and by a wider red stripe behind (II, 12) .... *fuliginosus* (Emmons)
15. Pronotum with prominent reddish-brown supra-humeral bands, anterior oblique vitta bordered before by a narrow black line and behind by a brownish-black line arising broadly at the pronotum margin and narrowing superiorly (II, 10) ..... *discoidalis* (Emmons)
    Pronotum not as above (II, 12) .... *fuliginosus* (Emmons)

Males

1. Pronotum with bright yellow markings 2
   Pronotum without bright yellow markings 3
2. Pronotum brown to black, rarely chestnut, dorsal carina with a broad elongate yellow stripe, anteapical vitta yellow (II, 17) .... *querci* (Fitch)
   Pronotum greenish-yellow anteriorly, brown to black posteriorly, yellow marking similar to above and with an oblique yellow-green vitta (II, 15) .... *helena* Woodruff

3. Pronotum with anterior oblique vitta completely obliterated from basal 1/3 almost to dorsal carina; mid-elytral band often indicated (II, 19) . . . . *pallidifrontis* (Emmons)
   Not as above 4
4. Pronotum before anterior oblique vitta pale yellow-green, mottled with light brown or pale green, metopidium often with a pair of darker spots or one large spot, anterior oblique vitta frequently apparently transverse (II, 18) . . . . *maculifrontis* (Emmons)
   Pronotum not as above 5
5. Elytra almost wholly reddish brown; anteapical vitta not obliterated in dorsal 2/3 (II, 13) . . . . *fuscipennis* Van Duzee
   Not as above 6
6. Pronotum abruptly elevated behind humeral angles; longer (7.2 mm or longer) (II, 22) . . . . *tuberosus* (Fairmaire)
   Pronotum not as above; shorter (6.4 mm or shorter) 7
7. Smaller (4.3 mm or shorter) (II, 21) . . . . *puritanus* Woodruff
   Larger (4.8 mm or longer) 8
8. Pronotum with mid-dorsal spot and anterior oblique vitta confluent . . 9
   Pronotum not as above 10
9. Pronotum brown to black, border pale from eye to anterior oblique vitta (II, 10) . . . . *discoidalis* (Emmons)
   Pronotum dark testaceous, densely irrorate with black on metopidium and before anterior oblique vitta (II, 9) . . . *arcuatus* (Emmons)
10. Pronotum with vittae and mid-dorsal spot rather obsolete (II, 11) . . . . *fenestratus* (Fitch)
    Pronotum not as above 11
11. Pronotum brown to black, border pale from eye to anterior oblique vitta (II, 10) . . . . *discoidalis* (Emmons)
    Pronotum not as above 12
12. Pronotum with prominent brown "V" between anterior oblique vitta and mid-dorsal spot 13
    Pronotum not as above 15
13. Pronotum moderately elevated anteriorly, anterior oblique and anteapical vittae approaching (often confluent) at margin of pronotum, arms of "V" usually of uniform width (II, 23) . . . . . *vau* (Say)
    Pronotum not as above 14
14. Pronotum before anterior oblique vitta washed with blackish red; smaller (5.3–5.6 mm) (II, 20) . . . . *pulchellus* Woodruff
    Pronotum not as above; larger (5.9–6.1 mm) (II, 14) . . *griseus* Van Duzee
15. Pronotum before anterior oblique vitta concolorous brown to black (II, 16) . . . . *inermis* (Emmons)
    Pronotum irrorate or mottled before anterior oblique vitta 16
16. Larger (6.2–6.4 mm) (II, 9); aedeagus with posterior arm widest below the middle in posterior aspect (I, 7) . . . . . . *arcuatus* (Emmons)
    Smaller (5.1–5.7 mm) (II, 12); aedeagus with posterior arm widest above the middle in posterior aspect (I, 8) . . . . *fuliginosus* (Emmons)

Genus *Ophiderma* Fairmaire

The typical pronotal pattern for this genus includes light colored suprahumeral and anteapical vittae. The pre-elytral hooks equal the elytral basal hooks of Woodruff (1919). They are not on the elytra but are on the sides of the thorax just before the bases of the elytra.

KEYS TO WISCONSIN SPECIES

Females

1. Color bright green 2
   Color gray, brown or black with lighter markings.................. 3
2. Larger (7.3–8.0 mm); pronotum usually marked with reddish posteriorly (II, 27); pre-elytral hook broad and blunt (I, 22)..*flava* Goding
   Smaller (6.2–7.0 mm); pronotum not marked with reddish (II, 26); pre-elytral hook more slender, upturned apically (I, 21) ....*evelyna* Woodruff
3. Eytra with dark band across the middle............................ 4
   Elytra without dark band across the middle......................... 6
4. Larger (7.4–8.8 mm) (III, 4)..................*salamandra* Fairmaire
   Smaller (5.7–6.2 mm) 5
5. Pronotum gray, without reddish shades (II, 25); length 6.0–6.2 mm ....*grisea* Woodruff
   Pronotum testaceous to reddish brown (II, 24); length 5.7–6.1 mm ....*definita* Woodruff
6. Larger (7.4–8.8 mm); more robust; pronotum moderately hairy (III, 4)...............................*salamandra* Fairmaire
   Smaller (6.3–6.9 mm); more slender; pronotum densely hairy (III, 3) ....*pubescens* (Emmons)

Males

1. Pronotum light brown, anterior half usually mottled with yellow green, vittae and longitudinal dorsal stripe usually present on dorsal carina white to yellow (III, 1)..............*evelyna* Woodruff
   Pronotum not as above.. 2
2. Elytra with dark band across the middle............................ 3
   Elytra without dark band across the middle......................... 4
3. Smaller (5.0–5.5 mm); more slender; pronotum light reddish brown to dark brown to black, pattern well defined or obscured, scantily haired (II, 24)...............................*definita* Woodruff
   Larger (5.5–6.0 mm); more robust; pronotum dark brown to black, pattern usually distinct, moderately hairy (II, 25)....*grisea* Woodruff
4. Pronotum reddish brown to black, vittae usually bright yellow, may be paler (III, 2); length 6.2–7.2 mm..................*flava* Goding
   Pronotum not as above.. 5
5. Smaller (5.5–6.0 mm); pronotum dark brown to black with vittae distinct, moderately hairy (II, 25).................*grisea* Woodruff
   Larger (6.0–7.5 mm); pronotum not as above 6
6. Smaller (6.0–6.5 mm); more slender; pronotum densely hairy, vittae distinct (III, 3)..........................*pubescens* (Emmons)
   Larger (6.8–7.5 mm); more robust; pronotum moderately hairy, vittae varying from distinct to almost obscured (III, 4) ....*salamandra* Fairmaire

Genus *Smilia* Germar

Smilia camelus (Fabricius) (III, 5) is the only species of this genus known to occur in Wisconsin.

Genus *Xantholobus* Van Duzee

The species considered in this paper to be in this genus have the pronotum with inflations before and behind the mid-dorsal foveae. This condition is often difficult to determine, and some gradation exists between it and the type of pronotum found in *Cyrtolobus* without distinct swellings. By pronotal characters the females are more easily placed in this genus than are the males. The occurrence of a small median protuberance on the incurved anterior margin of the connective serves as an additional character for the assignment of males to this genus.

X. *intermedius* (Emmons) has been assigned to this genus by the author (Dennis, 1951).

Keys to Wisconsin species

Females

1. Pronotum strongly elevated behind the humeral angles, markings distinct (III, 8) .... *muticus* (Fabricius)
   Pronotum not as above 2
2. Larger (7.0–7.5 mm); pronotum light to dark brown with lateral narrow yellow border, especially prominent on anterior part (III, 7) .... *lateralis* Van Duzee
   Smaller (5.9–6.4 mm); pronotum not as above (III, 6) .... *intermedius* (Emmons)

Males

1. Pronotum dark fuscous to black with lateral narrow yellow border (III, 7) .... *lateralis* Van Duzee
   Pronotum not as above 2
2. Larger (6.8–7.1 mm) (III, 8) .... *muticus* (Fabricius)
   Smaller (5.9 mm) (III, 6) .... *intermedius* (Emmons)

TRIBE TELAMONINI GODING

While using the key the insect should be viewed from the side. The arrangement of Ball (1931) is followed.

Key to Wisconsin genera

1. Pronotum with dorsal horn or crest 2
   Pronotum without dorsal horn or crest. Either low and rounded or high, compressed foliaceous 6
2. Pronotum with horn on anterior part situated above or in front of the humeral angles 3
   Pronotum with a crest, most of which is situated behind the humeral angles 4
3. Pronotum with horn extending anteriorly .... *Thelia*
   Pronotum with horn erect, compressed .... *Glossonotus*
4. Pronotum with crest quadrangular, slightly sinuate or rounded above, variable, but not definitely stepped, pyramidal or lobed .... *Telamona*
   Pronotum with crest neither quadrangular nor slightly sinuate nor rounded above but definitely stepped, pyramidal, or lobed 5
5. Pronotum with crest having dorsum definitely stepped, anterior lobe high and rounded, posterior lobe lower and quadrangular .... *Heliria* and *Telamona concava* Fitch
   Pronotum with crest pyramidal; posteriorly may be sinuate, with a slight step on the posterior slope, or with sinuation or step wanting .... *Palonica*
6. Pronotum low and rounding in frontal aspect; species not green .... *Carynota*
   Pronotum high, compressed and foliaceous; species green...... *Archasia*

Genus *Archasia* Stal

KEY TO WISCONSIN SPECIES

Pronotum of both sexes with dorsal crest overhanging in front, very high and foliaceous; bright green in life (III, 10)...*galeata* (Fabricius)

Pronotum of both sexes with dorsal crest not overhanging in front, lower; green with a slight smoky cast in life (III, 9)......*belfragei* Stal

Genus *Carynota* Fitch

KEY TO WISCONSIN SPECIES

Pronotum rich reddish-brown with creamy markings (III, 11) ....*marmorata* (Say)

Pronotum greenish-gray with an oblique black band just behind the middle (III, 12)....................................*mera* (Say)

Genus *Glossonotus* Butler

KEY TO WISCONSIN SPECIES

1. Pronotum with horn constricted near base in lateral aspect.......... 2
   Pronotum with horn broadest at base.................................. 3
2. Pronotum marked with a definite but variable rich brown and cream pattern (III, 14)..................................*crataegi* (Fitch)
   Pronotum obscurely marked, color dull gray-brown (III, 13) ....*acuminatus* (Fabricius)
3. Pronotum with horn much higher than wide, tapering; metopidium hairy; a pale median narrow stripe down posterior face of horn and dorsal carina to apex (III, 15)...........*turriculatus* (Emmons)
   Pronotum with horn nearly as wide as high; metopidium not hairy; a wide, pale, median stripe down posterior face of horn and dorsal carina to apex (III, 16).........................*univittatus* (Harris)

Genus *Heliria* Stal

KEY TO WISCONSIN SPECIES

1. Pronotum with anterior lobe not foliaceous and only slightly higher than the posterior lobe (III, 20)....................*molaris* (Butler)
   Pronotum with anterior lobe foliaceous or much higher than posterior lobe 2
2. Pronotum pale tawny, shading to gray-brown (III, 19) ....*cristata* (Fairmaire)
   Pronotum rich dark brown (III, 21)..............*scalaris* (Fairmaire)

Genus *Palonica* Ball

Ball, Rev. Tribe Tel. N. A.: 34–37, 1931.

KEY TO WISCONSIN SPECIES

Pronotum with crest acutely pyramidal, yellowish, creamy or gray-brown with dark brown markings (III, 18).........*pyramidata* (Uhler)

Pronotum with crest broadly obtusely pyramidal, dark (III, 17) ....*tremulata* (Ball)

Genus *Telamona* Fitch

Key to Wisconsin species

1. Pronotum of female wholly bright green (III, 24); pronotum of male yellow, with entire front of pronotum brown, an oblique dark brown band from top of posterior margin of crest to margin of pronotum, apex brown (III, 24) .... *unicolor* Fitch
   Pronotum not as above 2
2. Pronotum with crest very large, usually quadrangular, may overhang the metopidium 3
   Pronotum with crest smaller, usually rounding, if somewhat quadrangular placed well back on pronotum 7
3. Pronotum with crest vertical in front, 2/3 the length of the pronotum, uniform, pale testaceous, a creamy stripe on posterior face of crest (III, 22) .... *extrema* Ball
   Pronotum not as above, crest shorter 4
4. Species small (7–8 mm); pattern various (III, 27) .... *tristis* Fitch
   Species larger (9–11 mm) 5
5. Pronotum with crest definitely back of metopidium, usually strongly sinuate, pattern definite, crest dark brown (IV, 5, 6) .. *concava* Fitch
   Pronotum with crest almost over the metopidium 6
6. Pronotum dirty yellow-green, a definite black mark or pair of marks on margin of pronotum just behind the posterior margin of crest; black often extends from spots across the veins of the elytra (III, 23); valvula 2 with tip entire .... *maculata* Van Duzee
   Pronotum with tawny cast, no black spots as above (III, 26); valvula 2 with tip coarsely serrate (I, 23) .... *ampelopsidis* (Harris)
7. Pronotum with crest almost three times as wide as high or very low, long and rounding from the metopidium with a definite angle .. 8
   Pronotum at most twice as wide as high 9
8. Pronotum with posterior angle of crest prominent in female, in male obsolete or rounded; dirty yellow with a greenish cast (III, 25) .... *reclivata* Fitch
   Pronotum with crest very low, posterior angle obsolete or rounding; pale, mottled with brown or black (IV, 7) .... *westcotti* Goding
9. Species smaller (female less than 9.8 mm, male less than 8.3 mm); pronotum red, maculate with white or with pattern very distinct and bright colored 10
   Species larger (female 10 mm or larger, male 8.8 mm or larger); pronotum not as above 11
10. Pronotum with crest, inflated before and behind a median depressed area, red brown maculate with white .... *compacta* Ball
    Pronotum not as above (IV, 1) .... *decorata* Ball
11. Pronotum of female pale green or brown, male often dusky, both sexes with a coppery sheen, irrorate with white (IV, 3) .... *monticola* (Fabricius)
    Pronotum pale dirty yellow or greenish, markings dark 12
12. Larger (length female 10.5–12.0 mm; male 10.0–10.5 mm) (IV, 4A) .... *spreta* Goding[8]
    Smaller (length female 9.5–11.3 mm; male 9.3–10.0 mm) (IV, 2) .... *tiliae* Ball

[8] The variety *agrandata* Ball is illustrated (IV, 4B) but not considered distinct.

Genus *Thelia* Amyot and Serville

KEY TO WISCONSIN SPECIES

Pronotum of male very dark brown with a large yellow patch behind humeral angles, female gray; horn usually slightly curved upward (IV, 8) .... *bimaculata* (Fabricius)
Pronotum uniformly mahogany-brown; horn usually straight, its dorsal margin almost continuous with the line of the dorsum (IV, 9) .... *uhleri* (Stal)

TRIBE CERESINI GODING

The assignment of Wisconsin species to genera has been made, with modifications, according to the revision of Caldwell (1949).

KEY TO WISCONSIN GENERA

1. Base of corium with three longitudinal veins beginning near the base; pronotum not much elevated in front........................ 2
   Base of corium with two longitudinal veins contiguous at their bases; pronotum much elevated in front.............................. 3
2. Elytra with five apical cells, veins usually dark................*Acutalis*
   Elytra with four apical cells, veins usually very indistinct....*Micrutalis*
3. Styles broad, flat, apices obtuse (I, 4); aedeagus in lateral aspect with tip of posterior arm bilobed, the anterior lobe acuminate apically, the posterior lobe shorter and blunt (I, 11); pronotum very hairy..*Spissistilus*
   Styles acuminate apically in lateral or dorsal aspect or S-shaped with truncate apices in dorsal aspect only; aedeagus with posterior arm simple; pronotum moderately or scantily haired.............. 4
4. Styles acuminate apically in lateral or dorsal aspect......*Stictocephala*
   Styles S-shaped with truncate apices in dorsal aspect only (I, 5) ....*Tortistilus*

Genus *Acutalis* Fairmaire

Acutalis tartarea (Say) (IV, 10) is the only representative of this genus found in Wisconsin.

Genus *Micrutalis* Fowler

This genus is represented in Wisconsin by *Micrutalis calva* (Say) (IV, 11).

Genus *Spissistilus* Caldwell

The single species of this genus found in Wisconsin is *Spissistilus borealis* Fairmaire (IV, 12). This species has been assigned to this genus by the author (Dennis, 1951).

Genus *Stictocephala* Stal

S. constans (Walker) has been placed in this genus by the author (Dennis, 1951).

KEY TO WISCONSIN SPECIES

1. Species brown with light transverse bands.......................... 2
   Species green without transverse bands............................ 3
2. Larger (females 9.8–10.5 mm, males 8.4–9.0 mm); pronotum very hairy with two dark, rarely paler, brown transverse bands; elytra clouded (IV, 17); style with tip entire (I, 2)...........*diceros* (Say)

Smaller (females 8.4–9.2 mm, males 7.5–8.2 mm); pronotum scantily hairy, with sides ferruginous without definite dark bands as above; elytra hyaline or slightly clouded (IV, 16); style with tip serrate in ventro-lateral aspect (I, 3)......... *albescens* (Van Duzee)

3. Venter black; pronotum of male often strongly marked with black (IV, 18)....................................... *basalis* (Walker)

Venter without black markings; pronotum of male not strongly marked with black.. 4

4. Suprahumeral angles not developed into horns (IV, 15)..*lutea* (Walker)

Suprahumeral angles developed into horns........................... 5

5. Femora dorsally, coxae and often pectoral pieces marked with black; suprahumeral horns very short (IV, 19) ....*brevitylus dolichotylus* Caldwell

Femora, coxae and pectoral pieces not marked with black, suprahumeral horns longer... 6

6. Larger (females 9–11 mm, males 8.0–9.1 mm)...................... 7

Smaller (females 7.3–8.3 mm, males 7.2–7.4 mm).................. 8

7. Pronotum with metopidium concave (IV, 14); style with inner tip serrate in dorsal aspect (I, 1); valvula 2 with a single large tooth somewhat removed from the finely serrate tip (I, 24)..*taurina* (Fitch)

Pronotum with metopidium convex or straight (IV, 13); style with tip entire; valvula 2 with two (sometimes apparently only one) large teeth and a coarsely serrate tip (I, 27).....*bubalus* (Fabricius)

8. Pronotum with metopidium and dorsal carina strongly red-brown, horns strongly recurved (IV, 20); lateral valves with teeth suddenly convergent and narrowed in apical ¼ (I, 6); valvula 2 strongly narrowed before the finely serrate tip..*taurinaformis* Caldwell

Pronotum with metopidium and dorsal carina usually, but not strongly, marked with red; genitalia not as above................ 9

9. More robust (IV, 21); aedeagus with anterior face of posterior arm having lateral membranes extending ½ the distance to apex (I, 10); valvula 2 with tip entire and bluntly rounded (I, 26) ....*constans* (Walker)

More slender (IV, 22); aedeagus with anterior face of posterior arm having lateral membranes basal (I, 9); valvula 2 with tip finely serrate (I, 25).............................*palmeri* (Van Duzee)

Genus *Tortistilus* Caldwell

The author (Dennis, 1951) has placed *Tortistilus curvata* (Caldwell) in this genus.

KEY TO WISCONSIN SPECIES

Suprahumeral angles with minute horns (IV, 24); aedeagus with anterior face of posterior arm bearing a small hood-like sub-apical process and with the usual lateral membrane below this (I, 12); valvula 2 with a single large tooth near the entire tip (I, 28) ....*curvata* (Caldwell)

Suprahumeral angles not produced into horns (IV, 23); aedeagus without the small hood-like sub-apical process (I, 13); valvula 2 with a single large tooth somewhat removed from the coarsely serrate tip (I, 29)...*inermis* (Fabricius)

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Species—Host and Collection Data

Campylenchia latipes

Goldenrod, sweet clover, wild sunflower, alfalfa, alsike clover, American elm, black oak, giant ragweed, hazel, low, wet pasture vegetation, nettle, oak underbrush, red clover, roadside weeds, small ragweed, strawberry, swamp vegetation, white oak and unidentified weeds.

Enchenopa binotata

American elm, black locust, black oak, bur oak, butternut, forest floor, hard maple, hazel, linden, red oak, roadside weeds, shagbark hickory, smooth sumac and sweet clover.

Microcentrus caryae

Oak underbrush, "pin oak," shagbark hickory and white oak.

Entylia bactriana

Giant ragweed, goldenrod, bull thistle, bur oak, forest floor, prickly ash, red oak and shagbark hickory.

Pubilia concava

Giant ragweed, wild sunflower, black oak, bull thistle, bur oak, compass plant, forest floor, goldenrod, "grass," nettle, roadside weeds, sweet clover, and white oak.

Vanduzea arquata

Black locust, black oak and bur oak.

Vanduzea triguttata

Unknown for Wisconsin.

Cyrtolobus arcuatus

Black oak, bur oak and white oak.

Cyrtolobus discoidalis
Black oak, bur oak, red oak, white oak, "grass," shagbark hickory, and *Sporobolus* sp. Males also—light trap and tanglefoot boards.

Cyrtolobus fenestratus
Black oak and bur oak.

Cyrtolobus fuliginosus
Black oak, bur oak, northern pin oak, red oak, white oak, black locust, forest floor, "grass," hazel and shagbark hickory. Males also—light trap.

Cyrtolobus fuscipennis
Black oak, bur oak, red oak, white oak, black locust, forest floor and shagbark hickory.

Cyrtolobus griseus
Black oak, bur oak, red oak, white oak, apple and forest floor.

Cyrtolobus helena
Bur oak, bitternut hickory, black oak, chinquapan oak, swamp white oak and white oak. Males also—light trap.

Cyrtolobus inermis
Black oak, bur oak, red oak and white oak.

Cyrtolobus maculifrontis
Black oak, bur oak, red oak, swamp white oak, white oak, forest floor, haw and *Sporobolus* sp.

Cyrtolobus pallidifrontis
Black oak, bur oak, red oak, white oak, forest floor and shagbark hickory. Female also—fermenting bait.

Cyrtolobus pulchellus
Black oak, bur oak, forest floor, northern pin oak, red oak and white oak.

Cyrtolobus puritanus
Northern pin oak and red oak.

Cyrtolobus querci
White oak, bur oak, black oak and shagbark hickory.

Cyrtolobus tuberosus
Bur oak and white oak.

Cyrtolobus vau
Black oak, bur oak, white oak, black cherry, forest floor, prickly ash, red oak and shagbark hickory. Males also—light trap; females also—fermenting bait traps.

Ophiderma definita
Black oak, bur oak, red oak, white oak, forest floor and *Sporobolus* sp.

Ophiderma evelyna
Black oak, bur oak, northern pin oak, red oak, white oak, forest floor, haw and shagbark hickory. Males also—light trap.

Ophiderma flava
Black oak, red oak, white oak and forest floor.

Ophiderma grisea
Black oak, bur oak, red oak, white oak, forest floor, gray dogwood and tanglefoot boards. Males also—light trap.

PLATE I

Genital structures and pre-elytral hooks used in keys. All are drawn to same scale except 21 and 22 which show shapes only.

FIGURES 1–5 male style

1. *Stictocephala taurina,* right dorsal
2. *Stictocephala diceros,* right, dorsal
3. *Stictocephala albescens,* left, ventro-lateral
4. *Spissistilus borealis,* left, lateral
5. *Tortistilus inermis,* right dorsal
6. *Stictocephala taurinaformis,* tooth of lateral valve

FIGURES 7–15 male aedeagus

7. *Cyrtolobus arcuatus,* posterior arm, posterior aspect
8. *Cyrtolobus fuliginosus,* posterior arm, posterior aspect
9. *Stictocephala palmeri,* lateral
10. *Stictocephala constans,* lateral
11. *Spissistilus borealis,* lateral
12. *Tortistilus curvata,* lateral
13. *Tortistilus inermis,* lateral
14. *Entylia bactriana,* A lateral, B posterior arm, posterior aspect
15. *Pubilia concava,* A lateral, B posterior arm, posterior aspect
16. *Xantholobus* sp., connective
17. *Vanduzea arquata,* tergite IX, A oblique transverse carina
18. *Venduzea triguttata,* tergite IX
19. *Vanduzea arquata,* connective
20. *Vanduzea triguttata,* connective
21. *Ophiderma evelyna,* pre-elytral hook
22. *Ophiderma flava,* pre-elytral hook

FIGURES 23–29 tip of valvula 2 of female ovipositor, lateral aspect

23. *Telamona ampelopsidis*
24. *Stictocephala taurina*
25. *Stictocephala palmeri*
26. *Stictocephala constans*
27. *Stictocephala bubalus*
28. *Tortistilus curvata*
29. *Tortistilus inermis*

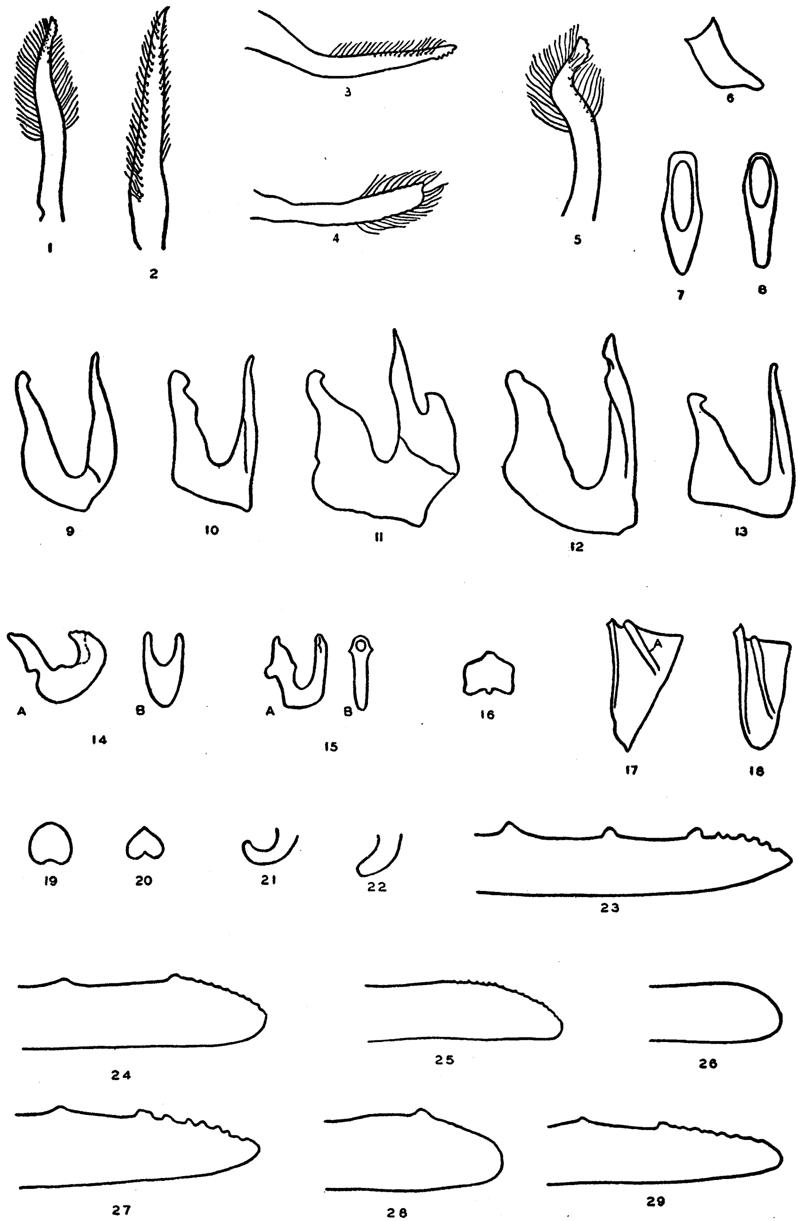
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PLATE II

Leg, heads, wings and pronotums

All are drawn to the same scale except 1, 2 and 3 which differ as follows: 1, six times; 2a and 3a, three times; and 2b and 3b half the scale of the others.

FIGURE

1. Membracinae, tibia of middle leg
2. *Enchenopa binotata,* A head, B pronotum
3. *Campylenchia latipes,* A head, B pronotum
4. *Microcentrus caryae,* A pronotum and wings, B variation of pronotum

FIGURES 5–27 pronotums

5. *Entylia bactriana*
6. *Pubilia concava*
7. *Vanduzea arquata*
8. *Vanduzea triguttata*
9. *Cyrtolobus arcuatus*
10. *Cyrtolobus discoidalis*
11. *Cyrtolobus fenestratus*
12. *Cyrtolobus fuliginosus*
13. *Cyrtolobus fuscipennis*
14. *Cyrtolobus griseus*
15. *Cyrtolobus helena*
16. *Cyrtolobus inermis*
17. *Cyrtolobus querci*
18. *Cyrtolobus maculifrontis*
19. *Cyrtolobus pallidifrontis*
20. *Cyrtolobus pulchellus*
21. *Cyrtolobus puritanus*
22. *Cyrtolobus tuberosus*
23. *Cyrtolobus vau*
24. *Ophiderma definita*
25. *Ophiderma grisea*
26. *Ophiderma evelyna*
27. *Ophiderma flava*

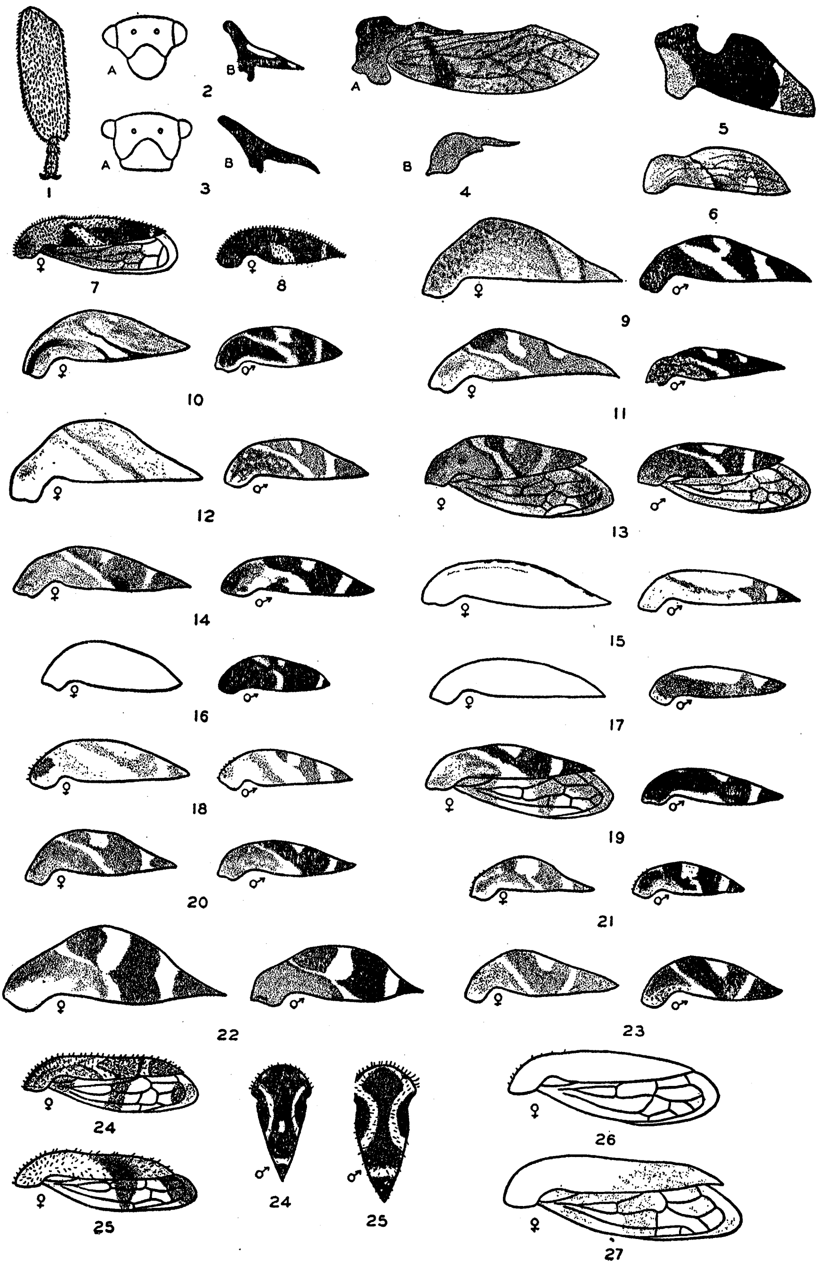
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PLATE III

Pronotums

Figures 1–4, 6–8 are drawn to the same scale; figures 5, 9–29 are drawn at half this scale.

FIGURE

1. *Ophiderma evelyna*
2. *Ophiderma flava*
3. *Ophiderma pubescens*
4. *Ophiderma salamandra*
5. *Smilia camelus*
6. *Xantholobus intermedius*
7. *Xantholobus lateralis*
8. *Xantholobus muticus*
9. *Archasia belfragei*
10. *Archasia galeata*
11. *Carynota marmorata*
12. *Carynota mera*
13. *Glossonotus acuminatus*
14. *Glossonotus crataegi*
15. *Glossonotus turriculatus*
16. *Glossonotus univittatus*
17. *Palonica tremulata*
18. *Palonica pyramidata*
19. *Heliria cristata*
20. *Heliria molaris*
21. *Heliria scalaris*
22. *Telamona extrema*
23. *Telamona maculata*, A lateral aspect B dorsal aspect, of anterior part of pronotum. H humeral angle
24. *Telamona unicolor*
25. *Telamona reclivata*
26. *Telamona ampelopsidis*, A lateral aspect B dorsal aspect, of anterior part of pronotum
27. *Telamona tristis*

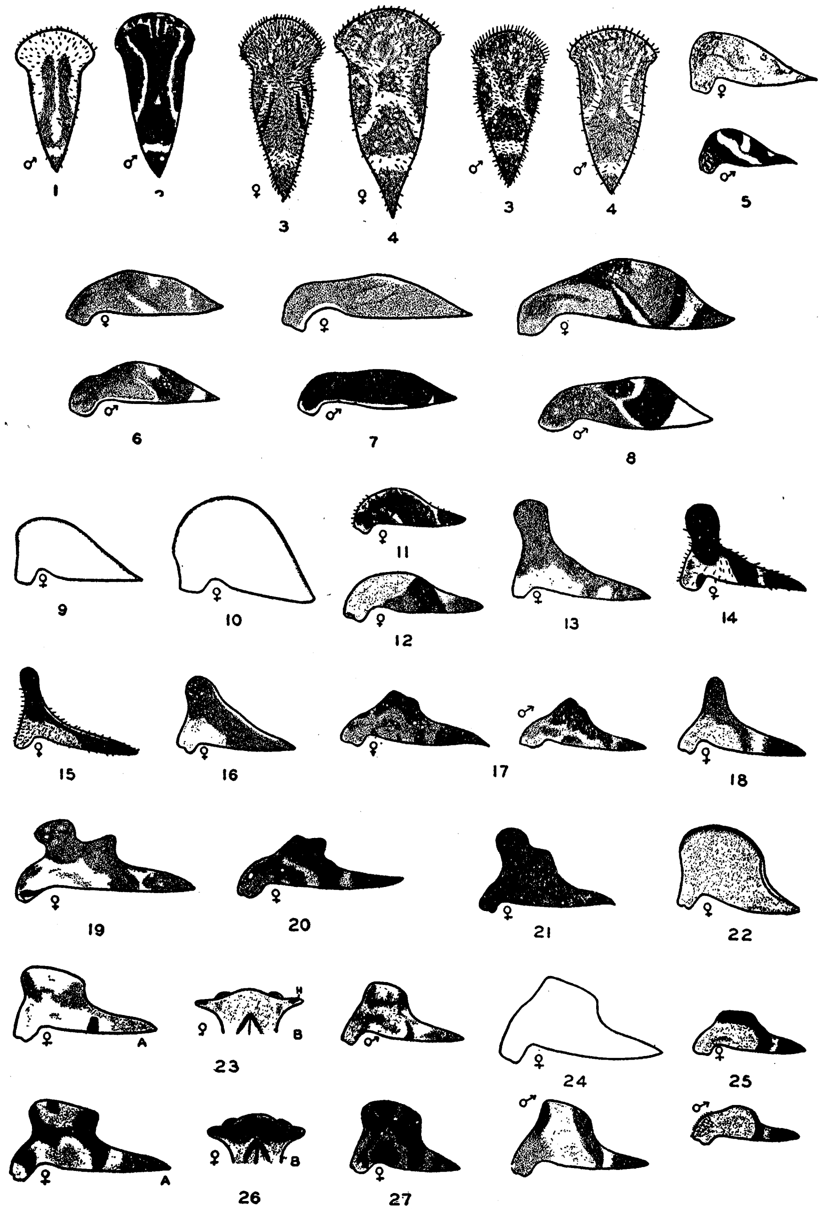
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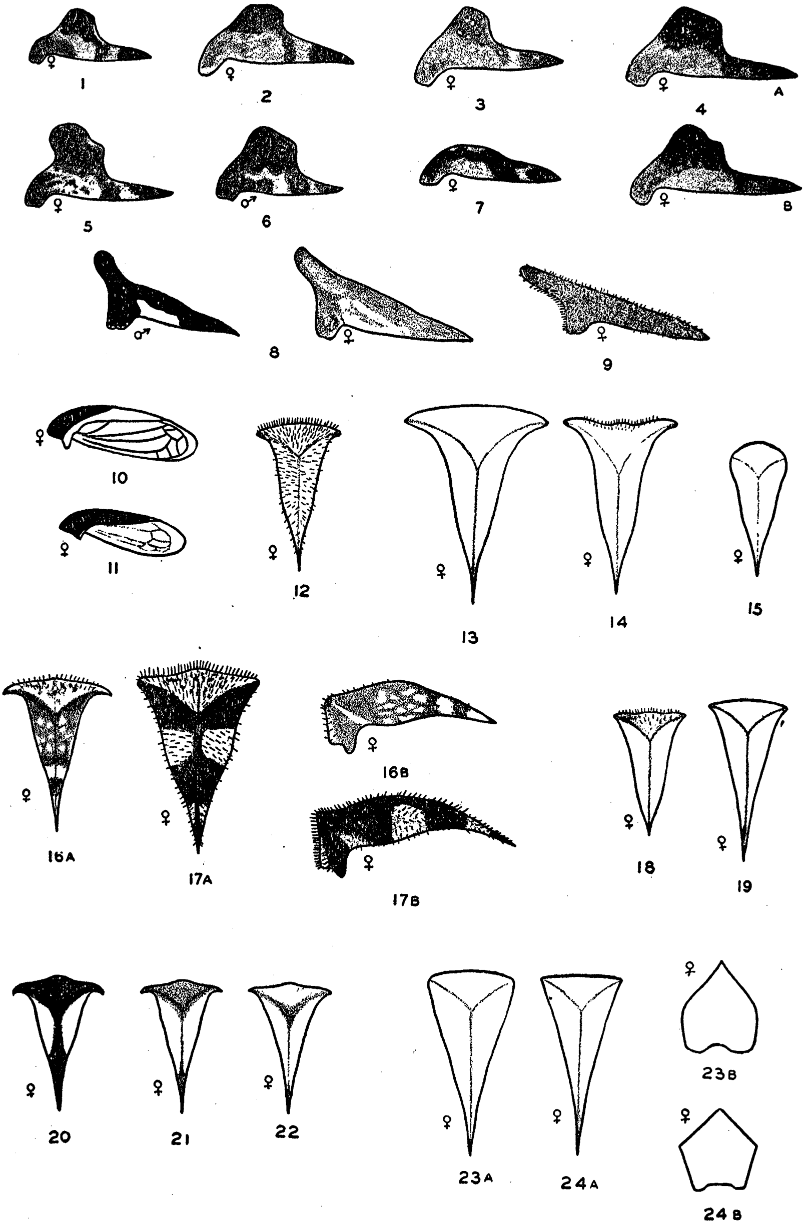
PLATE IV

Pronotums

Figures 1–10 are drawn to the same scale; 11 to twice, 12 to three times and 13–25 to one and one-half times this scale.

FIGURE

1. *Telamona decorata*
2. *Telamona tiliae*
3. *Telamona monticola*
4. *Telamona spreta,* A typical form, B variety *agrandata*
5. *Telamona concava,* more extreme form
6. *Telamona concava,* more typical form
7. *Telamona westcotti*
8. *Thelia bimaculata*
9. *Thelia uhleri*
10. *Acutalis tartarea*
11. *Micrutalis calva*
12. *Spissistilus borealis*
13. *Stictocephala bubalus*
14. *Stictocephala taurina*
15. *Stictocephala lutea*
16. *Stictocephala albescens,* A dorsal, B lateral aspects
17. *Stictocephala diceros,* A dorsal, B lateral aspects
18. *Stictocephala basalis*
19. *Stictocephala brevitylus dolichotylus*
20. *Stictocephala taurinaformis*
21. *Stictocephala constans*
22. *Stictocephala palmeri*
23. *Tortistilus inermis,* A dorsal, B frontal aspects
24. *Tortistilus curvata,* A dorsal, B frontal aspects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24B

Ophiderma pubescens
Black oak, bur oak, white oak and tanglefoot boards. Males also—light trap.

Ophiderma salamandra
Bur oak, red oak, black oak, white oak, forest floor, "grass," shagbark hickory and smooth sumac. Males also—at light and light traps.

Smilia camelus
Black oak, bur oak, red oak and tanglefoot boards. Both sexes at light.

Xantholobus intermedius
Black oak, bur oak, red oak, white oak and forest floor.

Xantholobus lateralis
Bur oak and white oak.

Xantholobus muticus
Black oak, bur oak, white oak and roadside weeds.

Archasia belfragei
Apple, black oak, bur oak, goldenrod, plum, red oak, wild grape and white pine.

Archasia galeata
Northern pin oak and black oak.

Carynota marmorata
Hazel and *Betula sanbergi* Britton.

Carynota mera
Shagbark hickory and bitternut hickory.

Glossonotus acuminatus
Red oak, white oak and tanglefoot boards.

Glossonotus crataegi
Haw.

Glossonotus turriculatus
Bur oak, forest floor and tanglefoot boards.

Glossonotus univittatus
Northern pin oak and forest floor.

Heliria cristata
Bur oak.

Heliria molaris
Bur oak and white oak.

Heliria scalaris
Haw.

Palonica pyramidata
Black willow.

Palonica tremulata
Quaking aspen. Male also—light trap.

Telamona ampelopsidis
Woodbine (Virginia creeper).

Telamona compacta
Black oak.

Telamona concava
Unknown for Wisconsin.

Telamona decorata
Black locust, black oak, bur oak, forest floor, hard maple, northern pin oak, red maple, red oak, shagbark hickory, white oak and tanglefoot boards. Male also—fermenting bait trap.

Telamona extrema
Black oak.

Telamona maculata
Bur oak.

Telamona monticola
Black oak, bur oak, forest floor, haw, northern pin oak, shagbark hickory, white oak and tanglefoot boards. Male also—fermenting bait trap.

Telamona reclivata
Bur oak, black oak and white oak.

Telamona spreta
Black oak, bur oak, red oak and white oak.

Telamona tiliae
Black oak, bur oak, green ash, hackberry, haw, linden, red oak, white oak, and tanglefoot boards.

Telamona tristis
Hazel, bur oak, forest floor, shagbark hickory and ironwood.

Telamona unicolor
Butternut, bur oak, forest floor and shagbark hickory.

Telamona westcotti
American elm, bur oak, forest floor, linden and white oak.

Thelia bimaculata
Black locust.

Thelia uhleri
Black cherry and wild plum.

Acutalis tartarea
Goldenrod, giant ragweed and wild sunflower.

Micrutalis calva
Swamp vegetation.

Spissistilus borealis
Sweet clover, apple, blackberry, black cherry, black locust, black ash, forest floor, giant ragweed, goldenrod, goosefoot, haw, hazel, nettle, prickly ash, raspberry, small ragweed and white oak.

Stictocephala albescens
Hazel, American elm, choke cherry, forest floor, goldenrod, prickly ash, raspberry, red oak and northern pin oak.

Stictocephala basalis
Forest floor, goldenrod, hazel, "mixed brush," red clover and swamp vegetation.

Stictocephala brevitylus dolichotylus
Black locust, "composite" and hazel.

Stictocephala bubalus

Sweet clover, apple, American elm, alfalfa, bean, bittersweet, blackberry, black locust, black walnut, bur oak, cherry, giant ragweed, goldenrod, haw, hazel, nettle, *Polygonum* sp., small ragweed, swamp vegetation, wild plum and wild sunflower.

Stictocephala constans

American elm, black cherry, black walnut, bur oak, forest floor, goldenrod, haw, hazel, linden, raspberry, red maple, red oak, sweet clover, weeds and white oak.

Stictocephala diceros

Blackberry, nettle, raspberry, American elm, bull thistle, dogbane, forest floor, giant ragweed, goldenrod, hazel, swamp vegetation, sweet clover, wild hemp and wild sunflower.

Stictocephala lutea

Black oak, bur oak, shagbark hickory, *Sporobolus* sp., sweet clover, white oak, and wild sunflower.

Stictocephala palmeri

Forest floor, hazel, red maple and white oak.

Stictocephala taurina

Alfalfa, apple, blackberry, black cherry, black locust, black raspberry, bur oak, dahlia, giant ragweed, goldenrod, goosefoot, hazel, linden, nettle, prickly ash, raspberry, red maple, shagbark hickory, small ragweed, sweet clover, wild grape, wild plum and wild sunflower. Males also—fermenting bait traps.

Stictocephala taurinaformis

Bur oak, forest floor, linden, red oak and underbrush.

Tortistilus curvata

Unknown for Wisconsin.

Tortisilus inermis

Sweet clover, alfalfa, apple, giant ragweed, hazel, ladino clover, red clover, small ragweed, strawberry and wild sunflower.

SEASONAL FLUCTUATIONS IN THE NUMBERS OF COCCIDIA OOCYSTS AND PARASITE EGGS IN THE SOIL OF PHEASANT SHELTER PENS**

HARRY G. GUILFORD* AND C. A. HERRICK
Departments of Zoology and Veterinary Science, University of Wisconsin

For many years the Conservation Department has maintained a large flock of breeding pheasants at the State Game and Fur Farm, Poynette, Wisconsin, in order to supply young and mature stock pheasants for the state. The ever-increasing demand for birds made it necessary to breed and raise the young pheasants on the same ground year after year. Soon after the start of the pheasant-raising program, the parasite problem became so important that the Conservation Department and the University of Wisconsin co-operated to get more information on the factors that had favored the increase and importance of the parasites. The results reported here were obtained during 1947 and 1948.

MATERIALS AND METHODS

Day-old pheasants were placed in brooder houses which were attached to shelter pens and these in turn to rearing pens. Approximately thirty such units were placed on each side of driveways to facilitate caring for the birds. Each unit was supplied with electricity and many with running water. One hundred fifty day-old pheasants were placed in each brooder house at the beginning of the season. At the age of one week these birds were given access to an adjoining shelter pen where they remained for a period of five weeks during which time they had access to both the house and shelter pen. Following this period they were also given access to a large run where they remained for six or seven weeks longer and where grass and weeds were abundant.

The shelter pens were square and had an area of 144 square feet. The soil within them was of a sandy nature and was partially shaded by a half roof over the pen. As soon as the pheasants were given access to this pen, they were fed and watered

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* Now at: Wisconsin Extension, Green Bay, Wisconsin.

there for the remainder of the season. Feeders and water fountains were placed in the center of the pens on screen frames which allowed any spilled feed and water to fall beneath them and out of reach of the pheasants. Early in the season there was a low growth of weeds but the soil became almost bare within two weeks after the young pheasants had access to it. The pheasants were cared for in the same manner as is described in detail in the Wisconsin Conservation Department Bulletin, *Pheasant Raising.*

The same ten shelter pens were used for experimentation in 1947 and 1948. They previously had been used for pheasant brooding for over ten years. The pheasant chicks were placed in these shelter pens on June 23 in 1947, and June 1 in 1948.

Every week soil specimens were taken approximately two feet from each corner of each shelter pen. A cork borer, 200 mm. in diameter, and marked so that the soil was removed to a depth of 15 mm., was used to remove soil specimens. The four specimens from each pen were placed in a numbered jar and within a short time, taken to the laboratory where they were mixed with water and small amount of detergent ("Tide" or "Breeze"). They then were allowed to stand overnight. Specimens were treated in this manner so that the soil particles would separate and the unharmed parasite eggs and oocysts would be free from the soil. With commercial detergents there was no precipitation, and the fine debris did not clump when placed in calcium chloride which was used in later steps of the procedure.

After the specimens had been allowed to stand for 12 to 18 hours, each specimen was shaken up, poured into a small 24-inch mesh sieve through which it was stirred and strained via a funnel, into a graduate with a diameter of 2.5 cms. The soil remaining in the sieve was washed with a fine spray of water until the graduate was filled to within one inch of the top or with approximately 110 cc. of water and soil. Only small stones and feed particles were left in the sieve after this spraying. The mixture in the graduate was permitted to settle about 30 minutes until all of the heavier material was at the bottom of the graduate.

A glass tube, 6 mm. in diameter, with both ends open was slowly pushed to the bottom of the graduate, and then with the finger placed over the upper end, the tube was withdrawn removing a column of strata within it. This sample was then placed in a test tube and centrifuged at 1000 rpm until all of the soil was sedimented. The water from this was decanted and approximately one half of one cubic centimeter of soil was left in the bottom of the tube.

Saturated calcium chloride with a specific gravity of 1.42 was added until the test tube was filled to within approximately one fourth of an inch from the rim. The sedimented soil was freed from the bottom and mixed with the calcium chloride by inverting the tube with the thumb over its mouth. This was then centrifuged at 600 rpm for 1 to 2 minutes during which time the parasite eggs and oocysts were floated to the surface free of debris.

A thin layer of petrolatum was spread around the rim of the test tube and calcium chloride was then added from below the surface of the solution in the tube by a fine glass pipette. This brought a meniscus with the eggs and oocysts above the edge of the test tube; it was prevented from running over the side of the tube by the thin layer of petrolatum.

A glass cover slip was held between the forefinger and the thumb and was slipped across the mouth of the test tube; then the meniscus was on the upper side of the cover slip. The meniscus was then drained into a depression slide, the under side of the cover slip was cleaned, and then the cover slip was inverted onto the depression slide. Experience showed that a definite sized meniscus filled the depression so as to allow only a very small air bubble to be under the slip and yet let it rest on the surface of the slide so there was no movement of the eggs while they were being counted. Only one layer had to be counted since the eggs and the oocysts floated next to the cover slip.

A commercial grade of calcium chloride was used to make the saturated solutions. The solution was allowed to stand for a time so that any fine material would sediment. In order to alleviate the possibility of air bubbles from collecting on the surface of the meniscus the solution had to be vacuumed prior to its use.

The slide was examined within an hour so the saturated calcium chloride did not harm the eggs and oocysts enough to spoil the count. After longer periods of time *Eimeria* oocysts collapse.

The efficacy of the technique for removing *Eimeria* oocysts from naturally infected soil was determined by running repeated samples from the same soil. In experiments to determine the numbers of oocysts removed, three, one-half cubic centimeter samples from each specimen of naturally infected soil were processed as described. Three menisci were built up and removed from each sample without disturbing the sediment. This was to see if any oocysts remained after the first and second menisci were removed. Each sample was then shaken up, recentrifuged, and three menisci were reformed and removed. This was repeated three to five times to see how many oocysts remained in the soil after the first centrifugation. Three samples from each specimen were run in this manner. The results are shown on Table 1. This table shows that an average of over 90% of the oocysts were recovered by the first meniscus of the first centrifugation, and that the number of oocysts recovered from the first meniscus of each of the three samples from one specimen were consistent.

TABLE 1

NUMBER OF *Eimeria* OOCYSTS RECOVERED FROM SAMPLES OF SOIL

Specimen Number	Sample from Graduate	Meniscus Number	Number of Coccidia: Centrifugings 1	2	3	4	5
	1	1	53	3	0	2	0
		2	0	0	0	0	0
		3	0	0	0	0	0
1	2	1	42	9	2	....	....
		2	0	0	0	....	....
		3	0	0	0	....	....
	3	1	52	0	0	....	....
		2	0	0	0	....	....
		3	0	0	0	....	....
	1	1	1,171	33	3	3	0
		2	15	2	0	0	0
		3	1	0	0	0	0
2	2	1	1,207	15	2	....	....
		2	43	0	0	....	....
		3	0	0	0	....	....
	3	1	1,004	40	0	....	....
		2	112	0	0	....	....
		3	0	0	0	....	....
	1	1	49	5	0	....	....
		2	3	0	0	....	....
		3	0	0	0	....	....
	2	1	53	3	0	....	....
		2	2	0	0	....	....
		3	0	0	0	....	....
	3	1	52	11	1	....	....
		2	5	1	0	....	....
		3	0	0	0	....	....

To test the consistency of the technique on *Heterakis* eggs, two one cubic centimeter samples were removed from each of 19 specimens of naturally contaminated soil and run in the same manner. The numbers of *Heterakis* eggs in the first meniscus from each sample were counted. The results are tabulated on Table 2. These data show that counts of *Heterakis* eggs were uniform, especially when one considers the small numbers of eggs in the soil.

TABLE 2

NUMBERS OF *Heterakis* EGGS FROM 1 CC. SAMPLES FROM SAME SPECIMEN OF SOIL

SPECIMEN NUMBER	NUMBER IN SAMPLE 1	NUMBER IN SAMPLE 2
1	25	19
2	16	28
3	23	23
4	14	18
5	10	21
6	12	12
7	10	13
8	7	14
9	10	10
10	15	3
11	9	7
12	4	7
13	2	10
14	4	6
15	5	4
16	3	2
17	3	2
18	1	1
19	1	1

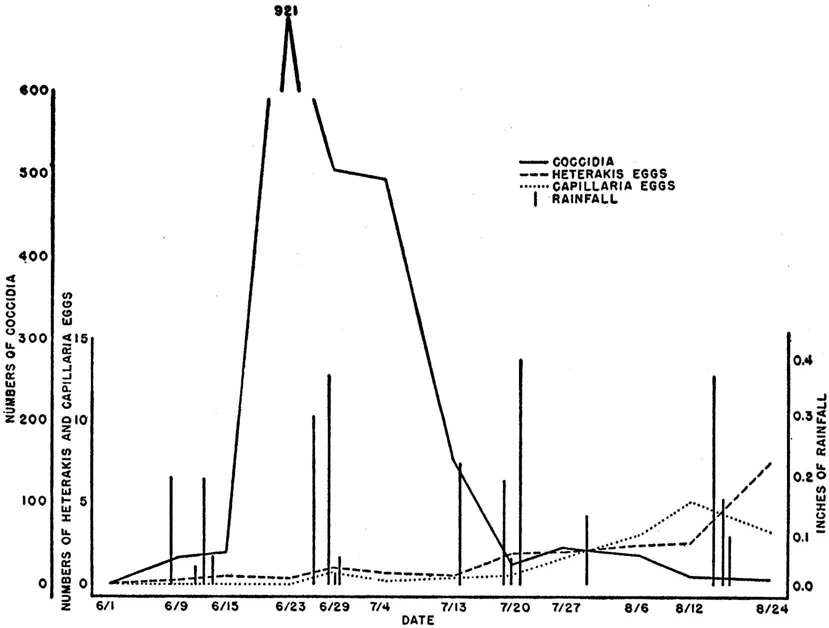
Since soil specimens were taken about two feet from each corner of the pens away from places of high and continually changing contaminations, such as near feeders and water fountains, and as droppings were carefully avoided, the technique was thought to be reliable for determining fluctuations of numbers of parasitic contaminants in shelter pens.

Rainfall data were taken daily throughout the brooding season with standard rainfall equipment.

RESULTS AND DISCUSSION

The results from the 1947 and 1948 studies are shown on Graphs 1 and 2, which show respectively for each year, the average numbers of *Eimeria* oocysts, *Heterakis* and *Cappillaria* eggs in each cubic centimeter of soil, as well as the rainfall, on successive weeks after the pheasants were placed in each of the ten pens. These graphs show that the average numbers of eggs or oocysts were at approximately the same level on the same week after the pheasants were on the ground in both 1947 and 1948, independent of the date that they were first placed in the pens.

The range of variation of the parasite eggs and oocysts in the ten pens is shown at the bottom of the graphs below the respective date. Graph 1 shows that a heavy series of rains fell during the first week that the pheasants were on the ground in 1947; later in this year the pens became very dry and dusty because of the lack of rain and long continuous heat. In 1948 there was rain wetting the soil on the week that the pheasants were placed on



	6/9	6/15	6/23	6/29	7/4	7/13	7/20	7/27	8/6	8/12	8/24
COCCIDIA	0-246	0-92	12-3000	60-2712	42-1082	90-274	2-38	10-148	26-86	4-38	0-32
HETERAKIS EGGS	0-2	0-2	0-2	0-8	0-6	0-4	0-14	0-18	0-12	0-8	2-38
CAPILLARIA EGGS	0-2	0	0	0-14	0-4	0-2	0-6	0-6	0-16	2-22	0-14

RANGE OF VARIATION AMONG TEN PENS

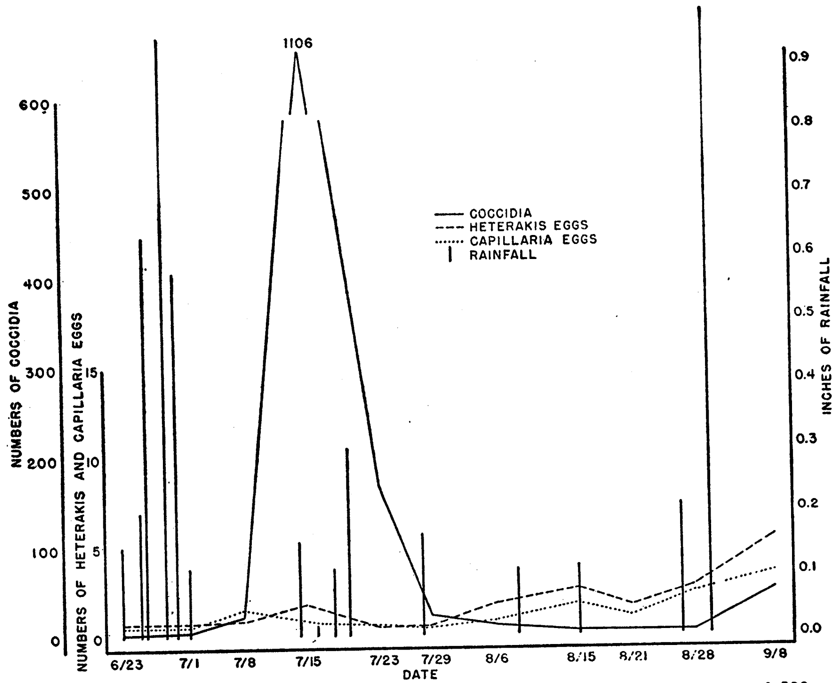
GRAPH 1. Showing the relation of rainfall to the number of coccidia oocysts and parasite eggs found in pheasant shelter pens in 1947.

the ground. None of the rains was as heavy as those in 1947, but they were more evenly spaced and consequently the ground, though dry at times, did not become dusty as it did in 1947.

The data on Graph 1 show that coccidia oocysts were found in the soil of several pens one week after the pheasants were placed on the ground in 1947. Within three weeks the numbers of oocysts had increased from none to an average of 1,100 per cubic centimeter of soil for each pen. They then disappeared rapidly within the following 2 or 3 weeks until only small numbers were found throughout the remaining part of the brooding season; this was true with one exception in which 500 oocysts were found

11 weeks after the birds had been on the ground. This latter case was thought to be due, possibly, to a dropping which was accidentally taken with the soil specimen.

Graph 2 shows the results obtained in 1948. Unsporulated oocysts were found on the soil one week after the pheasants were in the pens and the oocysts reached a peak of 921 per cubic centimeter by the third week. Thus the numbers of oocysts were



COCCIDIA	0-25	2-65	14-3000	14-1000	3-55	0-15	0-1	0-2	0-1	0-500
HETERAKIS EGGS	0-4	0-2	0-8	0-3	0-2	0-10	1-12	0-12	0-16	4-48
CAPILLARIA EGGS	0-6	0-6	0-5	0-2	0-2	0-8	0-20	0-5	0-15	0-15

RANGE OF VARIATION AMONG TEN PENS

GRAPH 2. Showing the relation of rainfall to the number of coccidia oocysts and parasite eggs found in pheasant shelter pens in 1948.

greatest in both 1947 and 1948 on the same week after the pheasants were on the ground, though they did not decline as rapidly nor as completely in 1948 as they did in 1947.

These data suggest that the initial spring rains made the soil a suitable environment for coccidia for several weeks. They also suggest that coccidia oocysts sporulated and infected most of the pheasants, and these then were responsible for depositing the large numbers of oocysts found three weeks after they were in the pens. The decline of the numbers of oocysts in the samples was thought to be due to the fewer numbers deposited after three weeks, the rapid disintegration of the oocysts with the onset of dry weather, and the fact that the pheasants after five weeks, had access to the runs and were therefore less crowded and were depositing fewer oocysts in the area of the shelter pen.

Graphs 1 and 2 show that only a small number of *Heterakis* eggs were found within the first 30 to 40 days after the pheasants were placed in the pens. Non-embryonated eggs were found from four to seven weeks after the chicks were placed in the pens. Embryonated eggs were found with them during the seventh week after the pheasants were on the ground in both 1947 and 1948. A sharp increase in the numbers of eggs was noted between the ninth and twelfth weeks. In 1947 the increase occurred between the ninth and eleventh weeks while in 1948 the increase was between the tenth and twelfth weeks.

Capillaria eggs were also found in small numbers during the early part of the brooding season and remained in small numbers for six to seven weeks in both years (Graphs 1 and 2). In 1947, on the seventh and eighth week after the pheasants were on the ground, eggs increased in the samples, until on the ninth to eleventh week relatively large numbers of *Capillaria* eggs were found. The data show a similar situation in 1948, indicating that there was a steady increase in the numbers of these eggs from the seventh to the twelfth week.

Since few disintegrated *Heterakis* or *Capillaria* eggs were found, the data suggest that these eggs were not destroyed by the hot dry weather and that most of those deposited remained in the soil throughout the brooding season.

It is evident from Graphs 1 and 2 that there were large numbers of *Heterakis* and *Capillaria* eggs in the shelter pens in the fall, and that they had been deposited in moderate numbers even when the pheasants had access to the runs. In the spring when the new hatch of pheasants was placed on the soil, the numbers of *Heterakis* and *Capillaria* eggs were much reduced. There was an average of 10.7 *Heterakis* eggs per cubic centimeter of soil in the fall of 1947, just before the pheasants were removed from the brooder line, but at the beginning of the 1948 season the same pens had an average of only 0.2 *Heterakis* eggs per cubic centimeter of soil. Thus over 98% of the eggs has disappeared over the winter. There was an average of 6.4 *Capillaria* eggs per cubic centimeter of soil over the winter when the pens were not in use. *Eimeria* oocysts were undetected in the soil in the spring of 1947 when a large number of samples were examined before the pheasants were placed on the ground. In 1948 no data were gathered from the pens before the pheasants were on the ground, but nine days after they were placed in the shelter pens, soil samples disclosed only unsporulated oocysts indicating that they were from fresh infections. This agrees with the results of Warner (1933), Delaphane and Stewart (1933), Patterson (1933) and Farr and Wehr (1949), all of whom worked on the survival of oocysts on the soil.

The numbers of *Syngamus* eggs are not shown on the graphs because their appearance in the soil samples was erratic. At some time during the latter part of the summer of 1947, disintegrated gapeworm eggs were found in all but one of the ten pens. Their presence followed a high incidence of gapeworm symptoms in the early and middle part of August. Very few gapeworm eggs were found in 1948. Since the weather was hot and dry during both brooding seasons, and even though gapeworm eggs were deposited in a viable state during both brooding seasons, evidence from soil samples indicated that very few, if any, of the *Syngamus* eggs survived long enough on the sandy soil of the Wisconsin State Game and Fur Farm to infect pheasants. Thus even though pheasants can become infected with gapeworms by ingesting the embryonated eggs it was a minor factor. Soil samples were taken during the last week of July from a game farm where a large amount of spilled feed and droppings held the moisture in the soil. At this time the pheasants had been on the ground for seven weeks. These samples were taken from five pens and examined in the same manner as previously described. There were respectively 40, 18, 16, 26, and 32 viable gapeworm eggs per cubic centimeter in these pens, indicating that moist conditions were necessary for the maintenance of gapeworm eggs.

Summary and Conclusions

A reliable technique for removing *Heterakis* eggs, *Capillaria* eggs and *Syngamus* eggs, and *Eimeria* oocysts from the soil was used to study seasonal fluctuations in the numbers of these parasitic contaminants in the soil of pheasant shelter pens on the Wisconsin State Game and Fur Farm.

Specimens of soil were gathered weekly from the same ten pens during the 1947 and 1948 brooding seasons.

Eimeria oocysts increased from a negligible number to an average of 1,106 per cubic centimeter of soil in 1947 and an average 921 in 1948, within three weeks after the pheasants were placed in the shelter pens. The numbers of oocysts declined in the fourth and fifth weeks, and only small numbers of them could be found from the fifth to the twelfth week after the pheasants were placed on the ground.

Heterakis eggs average 1.6 eggs per cubic centimeter of soil at the beginning of the brooding season of 1947, and 0.2 eggs per cubic centimeter of soil at the beginning of the 1948 brooding season. They increased in numbers during the late part of the brooding season in both years and on the eleventh week in 1947 they averaged 10.7 eggs per cubic centimeter, and on the twelfth week in 1948 they averaged 13.8 eggs per cubic centimeter of soil. There was a 98% decrease of these eggs over the winter when the pens were not in use.

Capillaria eggs averaged 1.0 eggs per cubic centimeter of soil at the beginning of the 1947 brooding season, and 0.2 eggs per cubic centimeter of soil at the beginning of the 1948 brooding season. They increased in numbers during the late part of the brooding season in both years, and on the eleventh week in 1947 they averaged 6.4 eggs per cubic centimeter of soil. There was a decrease of 97% in the number of these eggs over the winter when the pens were not in use.

Syngamus eggs were found to be disintegrated in the soil of hot, dry pens, but on another game farm where the soil was moist and covered with feed and droppings many viable gapeworm eggs were found in samples of soil.

ACKNOWLEDGEMENTS

The writers express sincere appreciation to director William Ouborn and assistant director B. A. Barger of the Wisconsin State Game and Fur Farm, and to all of the workmen, particularly Mr. Fuller and Mr. Grunkie, who with the spirit of cooperation and the willingness to spend time on extra details in addition to their regular duties, made these studies possible.

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PRELIMINARY LIST OF HARVESTMEN OF WISCONSIN WITH A KEY TO GENERA*

LORNA R. LEVI AND HERBERT W. LEVI
University of Wisconsin Extension Center, Wausau

After several years of intensive spider collecting, the authors found that they had accumulated also a moderate number of harvestmen. It was felt that if this collection were worked up, the information obtained from it might be of value or of interest, as no other list of the order has been compiled for this state. However, this list can not be considered complete, and further collecting must be done.

The papers of Davis and Bishop were found useful in making determinations. Dr. and Mrs. C. Goodnight very kindly identified those individuals which presented difficulties. Sincere thanks are offered to them as well as to Sister Mary Melanie and her students, Professor A. Hasler, Dr. N. Collias, Dr. D. Lowrie, Mr. R. Hunt, Miss R. Schiferl, and all others who contributed to the collection.

Thanks are also extended to Professors L. E. Noland and N. C. Fassett for help and encouragement which made possible several collecting trips throughout Wisconsin in the summer of 1949.

ARTIFICIAL KEY TO THE GENERA OF WISCONSIN HARVESTMEN

A. Some or all coxae with anterior and/or posterior marginal rows of denticles (fig. 1); terminal claw of palp toothed ventrally at base (fig. 3).

About 8 species, males ranging from 3.5 to 6 mm. in length. . *Leiobunum*

AA. Coxae smooth, spiny or hairy, but never with marginal rows of denticles; terminal claw of palp absent, or if present, not toothed.

- B. Terminal claw of palp absent.
  - C. Palp very long and slender, almost as long as first pair of legs; tibia and tarsus not swollen and only sparsely armed with fine setae.
    Male about 1 mm. in length. *Crosbycus*
  - CC. Palp stout; tibia and tarsus swollen and densely armed with bristles (fig. 2).
    Male about 3 mm. in length. . . . . *Sabacon*

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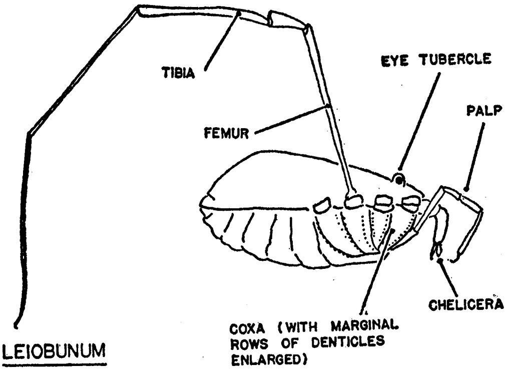
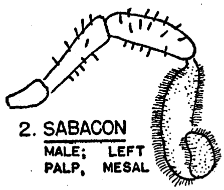
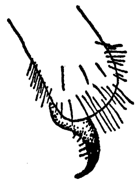
* Supported in part by the Research Committee of the Graduate School of the University of Wisconsin from funds supplied by the Wisconsin Alumni Research Foundation.



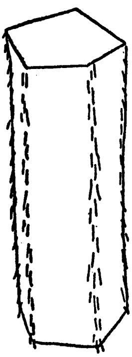
1. LEIOBUNUM



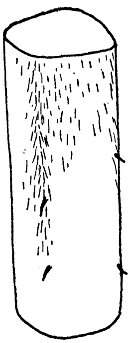
2. SABACON MALE; LEFT PALP, MESAL



3. LEIOBUNUM CLAW OF PALP

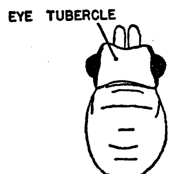


4. PHALANGIUM SECTION OF TIBIA IV



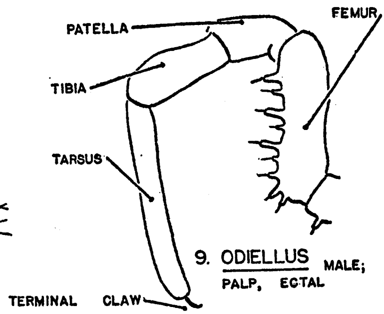
5. OPILIO. SECTION OF TIBIA IV

6. PHALANGIUM MALE; CHELICERA



7. CADDO BODY, DORSAL

8. ODIELLUS MALE; FEMUR, PATELLA & TIBIA OF LEFT PALP, DORSAL



9. ODIELLUS MALE; PALP, ECTAL

BB. Terminal claw of palp present.

D. Femur of palp with a ventro-lateral row of 3 to 10 stout spines, the longest being as long or almost as long as the femur is thick (fig. 9); femur of palp with a prominent distal median process (fig. 8); femurs of legs with bristles or hairs.

E. Eye tubercle nearly as wide as the thorax, and one third as long as the body (fig. 7); eye tubercle smooth and with a broad longitudinal canal; anterior margin of carapace in front of eye tubercle smooth; femur of palp only with distal median process.
Male about 1.4 mm. in length.................. *Caddo*

EE. Eye tubercle less than one sixth as wide as thorax, and less than one third length of thorax alone (fig. 1); eye tubercle with a row of spines on either side of the narrow longitudinal canal; anterior margin of carapace in front of eye tubercle with 3 stout spines; femur, patella and tibia of palp all with distal median processes (fig. 8).
Male about 5 mm. in length................. *Odiellus*

DD. Femur of palp with bristles, but no stout spines; palp segments without prominent distal processes; femurs of legs with rows of stout spines.

F. Tibia of fourth leg distinctly angular in cross-section, with rows of short setae on the angles (fig. 4); males have a prominent spur on the second segment of the chelicerae (fig. 6).
Male about 6 mm. in length.............. *Phalangium*

FF. Tibia of fourth leg round in cross-section with longitudinal rows of spines and hairs (fig. 5); males without spur on chelicerae.
Male about 5 mm. in length.................. *Opilio*

Class Arachnida

Order Phalangida (Opiliones)

Suborder Palpatores

Family Nemastomatidae Simon

Genus *Crosbycus* Roewer 1914

Crosbycus dasycmenus (Crosby), 1911. Taylor County: Chequamegon National Forest. This single specimen was found in Sphagnum.

Family Ischyropsalidae Simon

Genus *Sabacon* Simon 1879

Sabacon crassipalpe (L. Koch), 1879. Grant County: Wyalusing State Park. Kewaunee County: north of Kewaunee. Shawano County: Neopit. This and the following species probably occur in much greater numbers than this collection indicates. However, partly because of their small size, they may be easily overlooked.

Genus *Caddo* Banks 1892

Caddo agilis Banks, 1892. Douglas County: Cedar Island, Brule.

Genus *Odiellus* Roewer 1923

Odiellus pictus (Wood), 1870. Douglas County: Pattison State Park; Cedar Island, Brule. Fond du Lac County: Mauthe Lake, Kettle Morain State Park. Langlade County: Polar. Lincoln County: five miles west of Corning.

Genus *Phalangium* Linnaeus 1758

Phalangium opilio Linnaeus, 1758. This species is very common in all parts of Wisconsin.

Genus *Opilio* Herbst 1778

Opilio parietinus (De Geer), 1778. Crawford County: Prairie du Chien. Marathon County: Nutterville.

Genus *Leiobunum* C. L. Koch 1839

Leiobunum calcar (Wood), 1870. Ashland County: Copper Falls State Park. Door County: Peninsula State Park; Potawatomi State Park. Florence County: Tipler, Nicolet National Forest. Grant County: Fennimore.

Leiobunum flavum Banks, 1894. Grant County: Wyalusing State Park. Vernon County: Timber Coulee, Coon Valley.

Leiobunum longipes longipes Weed, 1887. This species is common in southern and central Wisconsin, but we have no records of it from counties north of Lincoln County, though it probably does occur farther north.

Leiobunum nigropalpi (Wood), 1870. Ashland County: Copper Falls State Park. Forest County: Laona. Jackson County: Castle Rock Roadside Park. Oneida County: Lake Tomahawk. Price County: Chequamegon National Forest, Memorial Grove. Walworth County: Wychwood; College Camp.

Leiobunum politum Weed, 1889. Adams County: Roche a Cri Roadside Park. Ashland County: Copper Falls State Park. Buffalo County: Merrick State Park. Chippewa County: Brunet Island State Park. Douglas County: Pattison State Park; Cedar Island, Brule. Fond du Lac County: Mauthe Lake, Kettle Moraine State Park. Forest County: Laona. Manitowoc County:

Point Beach State Forest. Oconto County: Machickanee County Forest. Price County: Chequamegon National Forest. Trempealeau County: Perrot State Park. Vernon County: Coon Valley; Wildcat Mountain State Park. Walworth County: Fontana.

Leiobunum ventricosum ventricosum (Wood), 1870. Douglas County: Cedar Island, Brule. Florence County: Tipler. Grant County: Wyalusing State Park. Walworth County: Wychwood; College Camp.

Leiobunum verrucosum (Wood), 1870. Waushara County: Wautoma.

Leiobunum vittatum (Say), 1821. This species is very common in all parts of Wisconsin.

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SOME EFFECTS OF THIOURACIL IN THE GERMAN BROWN TROUT[1]

ELDON D. WARNER
Zoology Department, University of Wisconsin
Milwaukee, Wisconsin

The goiterogenic action of thiourea in fish has been demonstrated by Goldsmith, *et al.* (1944). In experiments on viviparous hybrids of *Platypoecilus maculatus* x *Xiphophorus hellerii,* these workers found that the drug inhibited growth and development and brought about thyroid changes similar to those described in the higher vertebrates. The present study was undertaken to determine the effects of the related compound, thiouracil, on the eggs and fry of the German brown trout (*Salmo trutta fario*).

MATERIALS AND METHODS

Five hundred developing trout eggs were obtained 16 days after fertilization from the State Fish Hatchery at Madison, Wisconsin. Approximately half of the eggs were placed on a tray constructed of plastic screen and suspended in a 12-liter battery jar containing a 0.033% thiouracil[2] solution. The remaining eggs, serving as controls, were similarly suspended in a jar of water. Continuous aeration was supplied by an aquarium pump. The liquids in both experimental and control containers were changed twice weekly, the water used having been drawn from the tap at least three days prior to any given change. In order to maintain the low temperatures necessary for trout development, the battery jars were placed in a large galvanized tank through which cold tap water circulated. During the course of the experiment (from mid November until early May) the water temperatures varied from 8 to 15 degrees centigrade. Temperature changes from day to day were small and were the same in both battery jars. The effects of thiouracil on egg mortality and hatching time were noted.

Five days after hatching, 50 fry from thiouracil-treated eggs were transferred to 3-liter jars containing 0.033% thiouracil solutions. On the same day 100 fry from control eggs were placed in 3-liter jars of water. The two experimental and four control jars each contained 25 young trout. Twenty-six days later the

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[1] Supported by a grant from the Wisconsin Alumni Research Foundation.
[2] Courtesy of Lederle Laboratories.

water in two of the control jars was replaced by 0.033% thiouracil. Thus, two groups of thiouracil-treated fish were under observation, Series I having been immersed in the solution from the 16th day of embryonic life and Series II from the 31st day after hatching. The procedures for aeration, changing of liquids, and maintenance of low water temperatures were the same as described for the eggs. Beginning 25 days after hatching, the young trout were fed finely chopped fresh beef liver three times weekly.

At intervals during the experiment, eggs and fry were preserved in Bouin's fluid for histological study. Transverse serial sections of the head and anterior body regions were cut at 10 micra and stained with Delafield's hematoxylin and eosin.

RESULTS AND DISCUSSION

Egg mortality and hatching: In Figure 1, a graphic comparison is made between experimental and control eggs as to mortality and hatching time. Of the eggs developing in thiouracil, 13% died before or during the hatching period. The corresponding figure for the control eggs was 9%. Thiouracil, therefore, had only a slight toxic effect.

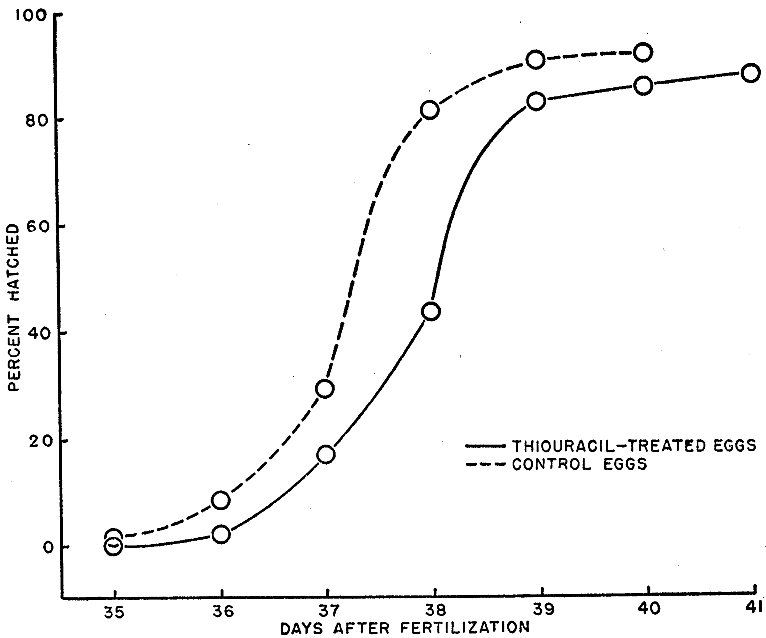


FIGURE 1. Percentages of thiouracil-treated and control trout eggs hatched between the 35th and 41st days after fertilization.

Hatching in the experimental jar took place between the 36th and 41st days after the eggs were fertilized. The greatest incidence was on the 39th day when 39% of the eggs hatched. In the control jar, the process began on the 31st day and continued until the 40th day with a peak of 52% of the eggs hatching on the 38th day. Thus, thiouracil produced a slight but definite delay in hatching. These results are confirmed by an earlier unpublished experiment (Warner, 1948) in which trout eggs developing in 0.033% solutions of thiourea and thiouracil were retarded about 24 hours in their hatching as compared to eggs developing in suspensions of carp pituitary powder and in water. Similarly, Grossowitz (1946) reported delays up to ten days in the hatching of hen's eggs after treatment with varying doses of thiourea. Although thiouracil treatment brought about a delay in the hatching of trout eggs, histological examination revealed no differences between experimental and control thyroids in fish preserved at that time. Therefore, it cannot be stated with certainty that the delay was the result of thiouracil-induced hypothyroidism.

Later development: For nine weeks after hatching the young trout appeared to be in good health, but between the 67th and 77th days a period of excessive mortality ensued. Inadequate diet and overcrowding were two of the more probable factors involved in the large number of fatalities. The incidence of death was highest among the Series I fry, only three individuals surviving until the 84th day when that portion of the experiment was terminated. At that time 12 Series II fry and 16 controls remained alive and in good condition. With the exception of specimens preserved at intervals for histological study these fish were observed until they attained an age of 154 days.

Certain external effects of thiouracil treatment became apparent during the post-hatching period. A delay in yolk-sac resorption was observed among the experimental fry of Series I. Six weeks after hatching this structure was still prominent in 50% of the thiouracil-treated individuals but was conspicuous in only 15% of the controls. Since the thyroids of the experimental fry were markedly enlarged at this time, the delay can be attributed to a hypothyroid condition brought about by thiouracil treatment. In the Series II fish no thyroid changes had occurred and there was no delay in yolk-sac resorption.

After immersion in thiouracil for 85 days (64 days post-hatching) bright reddish areas appeared in the ventral pharyngeal and pericardial regions of all Series I fry. The same situation developed in the Series II fish after 93 days of thiouracil treatment. This condition seemed to be due at least in part to an engorgement of the ventral aorta and its tributaries associated with enlargement of the thyroid gland.

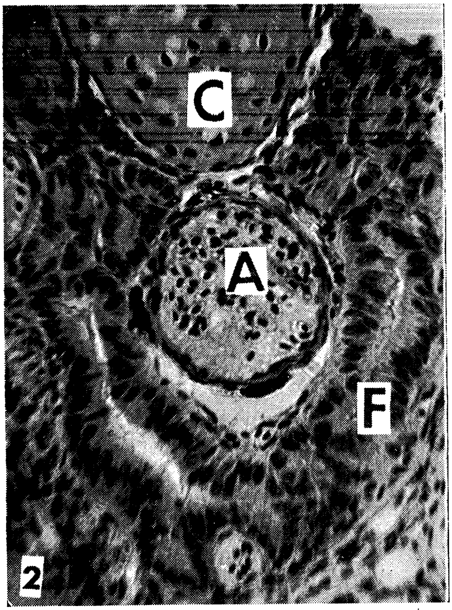
Between the 3rd and 44th days after hatching, the average body length of 25 Series I trout selected at random increased from 14.7mm to 27.1mm while over the same period an equal number of control fry similarly selected increased from 15.7mm to 27.8mm. Subsequent measurements on the 55th and 68th days after hatching showed no further gain in average body length among either experimental or control fry. It should be pointed out that this cessation of growth coincided roughly with yolk-sac resorption and immediately preceded the period of heavy mortality. It is possible, therefore, that the fry could not adapt themselves to the changeover from a yolk-sac type of nutrition to a liver diet. Overcrowding may also have been an important factor in growth stoppage and subsequent death. Among the Series II fry and their controls, some growth occurred during the later stages of the experiment. At 154 days after hatching, five thiouracil-treated fish had attained an average length of 33.9mm while six controls of the same age averaged 35.8mm. The foregoing measurements reveal no striking impairment by thiouracil of growth in length in either series of experimental fish.

Other more subjective changes in body proportion, coloration, and behavior were apparent in both Series I and Series II fry toward the end of the periods of thiouracil treatment. Several of the experimental fish presented a slightly humpbacked appearance. The head was relatively short and blunt and the gill region from a ventral view was abnormally broad. The body was comparatively thin in many cases although this may have been due in part to a lack of food in the alimentary canal. The vertical bands of dark pigment cells along the flanks were smaller and less well defined in a greater proportion of thiouracil-treated fry than in the controls. The experimental fish were for the most part more sluggish in their movements and less voracious in their feeding habits than the untreated fry.

Thyroid Histology: Histological studies of control thyroids (Figures 3 and 5) were made in conjunction with similar observations on both series of thiouracil-treated fish. As a result some aspects of normal thyroid development were noted which seem worthy of mention. They are summarized as follows:

(1) Small thyroid follicles containing colloid were first seen in 27 day embryos.

(2) In embryonic and early post-hatching stages the thyroid follicles were found in two separate groups close to the ventral aorta near the junctions of the first and second branchial arteries. In older fry, follicles were seen in almost all pharyngeal



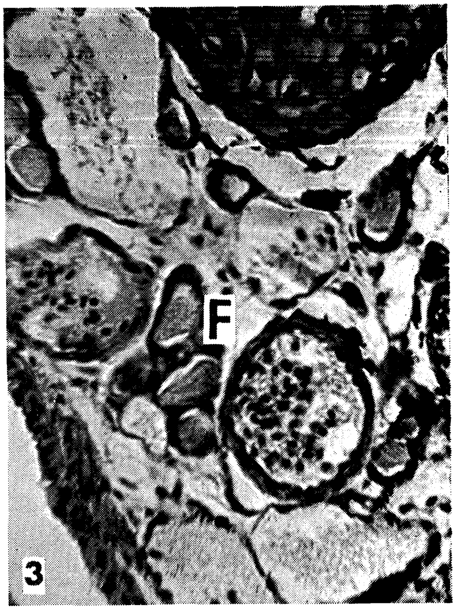


FIGURE 2. Thyroid gland of 63-day thiouracil-treated fry showing follicular hypertrophy, hyperplasia and loss of colloid. Transverse section at level of second branchial artery. C, cartilage of lower jaw; A, ventral aorta; F, thyroid follicle. X258.

FIGURE 3. Thyroid gland of 63-day control fry. Section at level of second branchial artery. F, thyroid follicle. X258.

FIGURE 4. Thyroid gland of 84-day thiouracil-treated fry showing loss of follicular organization. Section at level of second branchial artery. X258.

FIGURE 5. Thyroid gland of 84-day control fry at level of second branchial artery. X258.

sections at the levels of the 1st and 2nd gill arches with a few extending into the 3rd gill arch region. They were more diffusely arranged along the aorta than in earlier stages, but the heaviest concentrations were still near the bases of the first two pairs of branchial arteries.

(3) An increase in number of follicles occurred during the first two months after hatching. As an example, in a newly-hatched fry, 12 were counted, whereas in a fish 63 days old at least 100 were present. No marked increase beyond this number was noted in later stages.

(4) Considerable variation in follicle size was apparent in all stages studied. The extreme range in maximum diameters of those measured was between 10 and 65 micra. Relatively greater numbers of large follicles were present in older fish.

(5) Colloid was present in all follicles except those of extremely small size, and the amount per follicle appeared to increase somewhat with age. In most cases the colloid was slightly drawn away from the follicle cells.

(6) In young follicles the epithelium was cuboidal in nature while in later stages low cuboidal and squamous types predominated.

The thyroids of Series I experimental fish were studied in 16- and 27-day embryos and in 11 stages of fry between the ages of one and 84 days. Up to and including the time of hatching, no effects of thiouracil treatment were evident. The first change in thyroid histology was observed in an eight-day fry which had been immersed in thiouracil for 29 days. Here, a loss of follicular colloid was accompanied by a moderate cellular hypertrophy. At 25 days posthatching, marked thyroid enlargement was apparent. Colloid was almost completely absent and in several instances the lumens of the follicles were difficult to distinguish. In 63 day fry the thyroid had enlarged so as to fill almost the entire connective tissue space around the aorta (Figure 2). Measurements of several representative follicles showed a range in maximum diameters between 30 and 170 micra. Studies of successive sections revealed a folding or lobulation of the wall in follicles of extreme size. The lumens in most cases were slit-like and contained little or no colloid. Measurements of cells in the columnar type epithelium averaged 16 micra, about four times the height of cells in control thyroids of the same age. Distinct hyperplasia had occurred in 77- and 84-day thyroids, but many of the follicles, particularly in the latter stage, appeared to have lost their organization and follicular boundaries were not easily recognized (Figure 4). The cells for the most part were smaller than at 63 days although considerable variation in size was apparent. This atypical picture may have been the beginning of thyroid exhaustion, but the specimens studied were undoubtedly in poor health, having been preserved during or just after the period of widespread mortality. Therefore, factors other than thiouracil may have been involved in changing the histology of these glands.

In the second experimental series, nine stages of fry between the ages of 42 and 154 days were studied. Loss of colloid and cellular hypertrophy were first observed in two 50-day specimens. These fish had undergone thiouracil treatment for 19 days, a period of immersion ten days shorter than that required to produce hypothyroid symptoms in the Series I fry. The thyroids of month-old fry, therefore, appeared to be somewhat more susceptible to the effects of thiouracil than were those of 16-day embryos. These results may have been brought about by (1) greater sensitivity of the older thyroids to thiouracil, or (2) greater production or more effective utilization of thyrotrophic hormone from the hypophysis in the older fish.

Typical hypertrophy and hyperplasia occurred in the later Series II stages. The greatest enlargement was observed in a 154-day fish which had been under the influence of thiouracil for 123 days. Here, the thyroid formed a continuous compact mass around the ventral aorta throughout the gill arch region. Some of the follicles extended dorsally to the pharyngeal epithelium and laterally to the gill cartilages and gill arch muscles. The vascularity of the gland was more pronounced than that observed in younger specimens. Thus, the thyroids of Series II fry showed a progressive increase in size and number of cells with no indication of exhaustion in the later stages.

The picture of hypothyroidism brought about by thiouracil in the German brown trout resembles in several respects the syndrome of goiter in hatchery brook trout (*Salvelinus fontinalis*) described by Marine and Lenhart (1910). Pharyngeal reddening, lack of growth inhibition, sluggishness, and lowered viability were common to both species. The changes in thyroid histology of loss of follicular colloid, hypertrophy, hyperplasia, and migration of follicles to outlying areas also followed the same general pattern. The brook trout goiters were more extreme, many of them being observable externally. This greater development may be attributed to the more advanced age of the fish involved and to the much longer period of exposure to the goiterogenic factor. Another point of quantitative difference is the earlier and more complete loss of colloid observed in the thiouracil-treated glands of the German brown fry. The main causative agent of goiter in the brook trout was believed to be the diet consisting of hog liver and heart (Marine, 1914). It is of interest to note that the beef liver diet to which the German brown trout were subjected produced no histological symptoms of hypothyroidism.

Effects of thiouracil in young trout were in general the same as those obtained by Goldsmith and co-workers with thiourea in viviparous tropical hybrids. However, marked growth inhibition occurred in the latter fish but not in the former. Aside from species and drug differences, another factor involved in this discrepancy may have been the lower environmental temperatures to which the trout were exposed. As a result, the effectiveness of thiouracil in lowering metabolic rates may have been reduced, thereby causing less retardation of growth. The onset of histological symptoms of hypothyroidism in the trout occurred from 20 to 30 days earlier than that reported for the tropical fish. This would indicate a greater sensitivity of the trout thyroid.

It can be stated that the action of thiouracil in trout, particularly in its effect on thyroid histology, is comparable to that reported for birds and mammals.

Summary

Treatment of German brown trout eggs with thiouracil produced a slight delay in hatching time. Immersion of newly-hatched fry in thiouracil solutions for periods up to 154 days delayed yolk-sac resorption and decreased activity and viability, but caused little inhibition of growth in length. Marked thyroid enlargement occurred in fish exposed to thiouracil for more than 30 days.

Acknowledgments

Sincere appreciation is expressed to Dr. Roland K. Meyer for his suggestion of the basic problem and his critical appraisal of the finished paper. Special thanks are due Dr. Joseph G. Baier for considerable time and effort spent in perfecting some of the apparatus used in the above experiments.

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THE BIOLOGICAL EFFECT OF COPPER SULPHATE TREATMENT ON LAKE ECOLOGY

KENNETH M. MACKENTHUN AND HAROLD L. COOLEY
Public Health Biologists, Wisconsin Committee on Water Pollution

INTRODUCTION

The adequate control of algae is of great importance to the people living on the shores of fertile lakes. Since copper sulphate has been used in the control of algae for many years, many people have questioned the effects of continued treatment upon lake ecology. It is known that copper will accumulate upon the lake bottom following repeated treatments. To those who are conservation minded there is the question of what is the effect of accumulated copper upon bottom-dwelling organisms which are available as potential fish food. It has been pointed out by Nichols, Henkel and McNaul (1946) that the greatest amount of accumulated copper (Cu) is found at the greatest depths in the lake and therefore if a toxic action were present it should exert the greatest effort on the profundal organisms. This paper is an outgrowth of studies designed to formulate an answer to this basic question. It is hoped that this preliminary work will encourage a greater amount of research aimed at solving the problem of algae control.

Experimental copper sulphate treatment for the control of algae was begun as early as 1918 on the Madison lakes. More extensive control started in 1925 when Domogalla (1926) reported that 108,600 pounds of copper sulphate was used on Lake Monona, a lake of 3,482 acres, between May and September. During the early years of this program the chemical treatment operations were not supervised by a state agency. A need existed for some type of control over such a program and in 1938 an Executive Order created an interdepartmental committee presently consisting of representatives from the State Board of Health, the Wisconsin Conservation Department, and the State Laboratory of Hygiene. The functions of this committee are to approve and supervise nuisance control activities and procedures wherever conducted in the state, to conduct research to determine the effect of control measures in the application of chemicals, and to test and develop control methods that will abate nuisances without serious deleterious effects upon other aquatic life.

After many years of continuous copper sulphate treatment, particularly on the Madison lakes, questions arose regarding the possible deleterious effect which this treatment might have upon the fish population of the treated waters. Hasler (1947) and Schoenfeld (1947, 1950) were foremost in calling attention to this possibility. The Wisconsin Committee on Water Pollution (1939) has shown that fish will not be killed in concentrations of copper sulphate normally used for algal control. Also, Domogalla (1935) found that the zooplankton was not affected by copper sulphate treatment by eleven years of chemical treatment of the Madison lakes. The chief criticism of algal control by this method lay in the possible deleterious effect of accumulated copper in the bottom muds upon bottom-dwelling organisms.

Bottom Productivity

Juday (1922) in a quantitative study of the bottom fauna of the deeper waters of Lake Mendota found an average of 3,500 Tubifex and Limnodrilus; 557 fingernail clams, *Pisidium idahoense;* 593 bloodworms, *Chironomus tentans;* and ±25,000 phantom chironomids, *Corethra punctipennis* per square meter of bottom. A considerable variation in the density of the population existed at different stations, at different depths, and at different seasons of the year. The peak of the population density was found to occur during the months of January and February. Adamstone and Harkness (1923) and Adamstone (1924) found that the number of bottom organisms per square meter in Lake Nipigon, Canada, varied from 753 to 1,057. Eggleton (1934) conducted a study aimed at a comparison of the benthic population in four lakes in northern Michigan which are geographically closely situated but ecologically widely different. He found the population density ranged from 294 to 7,200 organisms per square meter. Calhoun (1944) in his study of the bottom fauna of Blue Lake, California, found 16 to 135 organisms per one-fourth square foot Ekman dredge haul.

In an effort to determine the possible effect of continuous copper sulphate treatment upon bottom productivity, four lakes were chosen for study in Wisconsin. Two of the lakes lie in the Madison lake area and two lie in the Oconomowoc–Waukesha lake area. Table 1 presents the physical and historical characteristics of these bodies of water.

Lake Mendota was the largest of the lakes studied and lies above Lake Monona in the Madison lake chain. The primary source of nutrients entering this body of water occur from natural land drainage. Lake Monona, on the other hand, has received a portion of the sewage effluent from the City of Madison until 1950 with the exception of a brief period between 1937 and 1942 when the Burke treatment plant was closed. In addition, the majority of the City of Madison storm sewers discharge directly into Lake Monona. As a result, Lake Monona has presented a continuous algae problem, and rough fish have also become abundant under these ecological conditions.

TABLE 1

PHYSICAL AND HISTORICAL CHARACTERISTICS OF WATERS STUDIED

	LAKE MENDOTA	LAKE MONONA	LAKE NAGA-WICKA	LAKE PEWAUKEE
Location, county	Dane	Dane	Waukesha	Waukesha
Area, acres	9,729	3,482	918	2,298
Maximum depth, feet	84	74	95	45
Length of shoreline, miles	20.1	13.3	7.0	12.1
Volume, million cubic meters	478	118	41	37
Yrs. of copper sulphate treatment	No appreciable amount of treatment.	26	None	3
Pounds of copper sulphate applied		1,697,639	None	26,000

The copper sulphate applications for algae control on Lake Monona have been the heaviest of any waters in the state. Over a 26-year period, 1,697,639 pounds of copper sulphate have been applied, whereas Lake Mendota has received no appreciable treatment. Lake Pewaukee has received a shoreline treatment for the past three years of 26,000 pounds of copper sulphate. Lake Nagawicka was chosen as a control since it has received no treatment for algae control.

In the present study, all bottom samples were taken with an Ekman dredge during the months of January and February at a time when population abundance was at a peak. Sampling stations were chosen along four transverse lines extending into the deeper waters of the lake. An attempt was made to locate at least ten stations for every ten-foot change in the contour of the lake bottom. The samples were placed in five-quart pails after collection and transported to the laboratory where they were screened through a U. S. Standard #35 sieve and the organisms so retained were placed in 10% formalin for identification and enumeration.

TABLE 2

AVERAGE NUMBER OF ORGANISMS PER SQUARE METER OF BOTTOM

Figure in parenthesis represents total organisms excluding *Corethra punctipennis*

LAKES	MENDOTA	MONONA	NAGA-WICKA	PEWAU-KEE
Average organisms per sq. m.	7,567 (7,154)	1,109 (1,014)	1,979 (1,532)	1,623 (1,340)
Number of Samples	59	65	28	30
0–10 ft. Contour	11,593 (11,593)	2,507 (2,507)	*	*
Number of Samples	6	7		
10–20 ft. Contour	8,789 (8,789)	1,202 (1,202)	*	1,176 (1,176)
Number of Samples	8	15		5
20–30 ft. Contour	5,274 (5,269)	802 (802)	*	2,228 (2,228)
Number of Samples	9	8		5
30–40 ft. Contour	3,218 (3,218)	987 (963)	638 (627)	1,733 (1,503)
Number of Samples	6	11	8	6
40–50 ft. Contour	2,455 (2,406)	781 (656)	1,850 (1,841)	1,568 (1,023)
Number of Samples	7	12	5	13
50–60 ft. Contour	8,156 (7,838)	594 (402)	1,481 (1,451)	....
Number of Samples	10	9	4	
60–70 ft. Contour	9,746 (8,404)	1,419 (530)	2,325 (287)	....
Number of Samples	10	3	6	
70–80 ft. Contour	10,808 (8,371)	....	....	....
Number of Samples	3			

*Inadequate samples to calculate averages.

At the same time, samples were retained for total copper determinations in the bottom muds. Nichols *et al.* (1946) in an extensive study of this problem, report that 18 to 1,093 milligrams of copper per kilogram of bottom mud (dry weight) was found in Lake Monona and 32 to 135 milligrams of copper per kilogram of bottom mud (dry weight) was found in Lake Mendota. The greatest concentrations of copper were found in the deeper portions of the lake and it seems that the natural grading process tends to carry the precipitated copper compounds to the lower levels.

The results obtained in the present study are in general agreement, but the amount of copper contained in the bottom mud of Lake Monona is somewhat lower. The problem in recent years has not been so acute, and the total amount of treatment conse-

TABLE 3

Relative Abundance of Various Organisms per Square Meter of Bottom

% is the per cent of occurrence in samples   Ave. is the average number of organisms per square meter

	Total		0–10 ft.		10–20 ft.		20–30 ft.		30–40 ft.		40–50 ft.		50–60 ft.		60–70 ft.		70–80 ft.	
	%	Ave.	%	Ave.	%	Ave.	%	Ave.	%	Ave.	%	Ave.	%	Ave.	%	Ave.	%	Ave.
L. Mendota																		
Chironomus	100	4180	100	9390	100	5868	100	2187	100	1262	100	952	100	3694	100	4537	100	5332
Procladius	80	243	33	151	50	86	89	215	85	631	100	227	90	215	80	267	100	201
Corethra	39	413	....	....	....	....	11	5	....	....	14	49	80	318	100	1342	100	2437
Oligochaeta	93	1459	67	258	75	108	100	282	100	401	100	878	100	3350	100	3092	100	2422
Pisidium	88	490	83	96	75	366	78	1018	100	616	84	227	100	560	90	499	100	416
Miscellaneous	36	782	100	1671	100	2361	100	1567	100	308	43	122	40	19	20	9	....	....
L. Monona																		
Chironomus	89	286	100	878	93	324	63	162	100	204	100	89	78	53	100	172	....	....
Procladius	65	145	14	25	53	86	75	247	100	282	83	140	55	96	100	286	....	....
Corethra	34	95	....	....	....	....	....	....	18	24	67	125	100	192	100	889	....	....
Oligochaeta	94	576	86	1573	93	705	88	382	100	477	100	423	100	253	67	72	....	....
Pisidium	2	1	....	....	7	58	....	....	....	....	....	....	....	....	....	....	....	....
Miscellaneous	9	6	29	31	7	29	25	11	....	....	8	4	....	....	....	....	....	....
L. Nagawicka																		
Chironomus	93	544	....	*	....	*	....	*	100	351	80	103	100	597	83	179	....	....
Procladius	41	89	....	*	....	*	....	*	90	167	60	387	....	....	....	....	....	....
Corethra	45	447	....	*	....	*	....	*	13	11	20	9	60	32	100	2038	....	....
Oligochaeta	76	682	....	*	....	*	....	*	65	97	100	1342	100	849	67	108	....	....
Pisidium	14	7	....	*	....	*	....	*	....	....	20	9	....	....	....	....	....	....
Miscellaneous	21	190	....	*	....	*	....	*	13	12	....	....	....	....	....	....	....	....
L. Pewaukee																		
Chironomus	100	1050	....	*	100	386	100	1539	100	1381	100	1020	....	....	....	....	....	....
Procladius	20	10	....	*	60	34	20	9	17	7	8	3	....	....	....	....	....	....
Corethra	60	282	....	*	....	....	....	....	100	230	92	545	....	....	....	....	....	....
Oligochaeta	37	78	....	*	40	60	100	310	67	79	....	....	....	....	....	....	....	....
Pisidium	37	60	....	*	100	206	100	146	17	7	....	....	....	....	....	....	....	....
Miscellaneous	43	143	....	*	100	490	100	224	33	29	....	....	....	....	....	....	....	....

*Inadequate samples to calculate averages.

quently has been reduced. Our findings indicate that the bottom muds of Lake Monona contain up to 480 milligrams of copper per kilogram of mud on a dry-weight basis, whereas Lakes Nagawicka and Pewaukee contain up to 22 and 55, respectively.

Table 2 gives the average number of organisms found at the various depth contours for the lakes studied, and Table 3 presents the relative abundance of various types of organisms in each of the lakes. It is interesting to note that the bloodworm, *Tendipes plumosus,* first appeared in Lake Mendota at the 50-foot contour and remained abundant throughout the deep-water area. Very few of this species were observed in either Lake Monona or Nagawicka, but they were fairly abundant throughout the entire Lake Pewaukee area. The phantom chironomid, *Corethra punctipennis,* first appeared between the 30- and 50-foot contours in all of the lakes. The greatest concentration of these organisms occurred in the deeper waters of the lakes. Oligochaeta worms were quite erratic in population density. In Lake Mendota they were concentrated in waters in which the depth exceeds 40 feet. Conversely in Lakes Monona and Nagawicka the Oligochaeta were concentrated in shallow water up to a depth of 50 feet, and in Lake Pewaukee very few worms were found beyond a depth of 35 feet. The fingernail clam, *Pisidium idahoense* was concentrated at the 20–30-foot contour in Lake Mendota although they were present over the entire lake bottom. These organisms were very rare in Lakes Monona and Nagawicka, and few were found in depths exceeding 25 feet in Lake Pewaukee. It is interesting to note that the population of profundal organisms found in Lake Mendota during the present survey varies from the results found by Juday only in the relative numbers of bloodworms and phantom chironomids found per unit area. About seven times more bloodworms were found per unit area during the current survey but only one-tenth as many phantom chironomids were found as compared to the 1922 survey.

The total population of bottom organisms varied greatly between the separate waters and also between the various depths within the same body of water. The population of bottom organisms in Lake Mendota greatly exceeded that found in any of the other lakes. Lake Mendota further demonstrated the greatest variation between the depth contours. Two areas of population density occurred—one in the littoral area and one in the profundal. The low point in population density was apparent at the 30–60-foot contour. Eggleton (1931) in his studies of two Michigan lakes found that a zone of concentration of profundal bottom animals occurred in the upper profundal and lower sub-littoral regions during the summer. This zone shifted downward in autumn and upward in spring. The number of species and of individuals varied with the season in different lakes and in different depressions within the same lake.

Statistical consideration was given to the total number of organisms per square meter for all samples taken at a depth of 30 feet or greater. Thirty-six samples were taken in excess of 30 feet in Lake Mendota. These contained a mean of 6,935 organisms per square meter with a standard deviation of 4,105 and a standard error of the mean of 684. The 35 samples from Lake Monona possessed a mean of 849, a standard deviation of 432, and a standard error of the mean of 73. In Lake Nagawicka, 23 samples taken at a depth greater than 30 feet possessed a mean of 1,619, a standard deviation of 1,795, and a standard error of the mean of 374. The 19 samples from Lake Pewaukee had a mean of 1,620, standard deviation of 602, and standard error of the mean of 137. In comparing possible similarity between any two sets of data, Lakes Monona and Nagawicka, as well as Lakes Pewaukee and Nagawicka, were found to be significant. All other combinations of data are not significant.

Toxicity of Precipitated Copper Sulphate to Bottom Organisms

Experiments were conducted to determine the effect of precipitated copper sulphate mixed in known quantities of lake mud upon bottom-dwelling organisms. Commercial copper sulphate was precipitated in hard lake water and a weighed portion of the precipitate suspension was thoroughly mixed in a small amount of lake mud from untreated Lake Mendota by means of a Waring Blendor. The stock mud was then thoroughly mixed, by means of an electric mixer, in varying proportions with normal lake mud and one kilogram was placed in each of several identical test jars. After the mud was superimposed with one litre of lake water, normal organisms removed from Lake Mendota were placed in each of the test jars. A total of 25 *Tendipes plumosus* and 15 *Pisidium idahoense* were placed in each. The experimental jars were placed in a constant temperature water bath at 9°C. for 60 days. The experimental organisms were counted at the end of 30 days and again at the end of 60 days. Two controls were established for each set of 10 experimental jars. The results of the experiments (A.B.C. and D.) are tabulated at the end of the paper. In one experiment with copper concentrations as high as 750 milligrams per kilogram of mud on a dry weight

EXPERIMENT A

TEST JAR	COPPER CONCENTRATION mg./kg. (dry mud)	TENDIPES PLUMOSUS (25 in each jar)		PISIDIUM IDAHOENSE (10 in each jar)	
		Per cent survival 30 days	Per cent survival 60 days	Per cent survival 30 days	Per cent survival 60 days
1	Control	100	84	100	80
2	Control	100	80	100	90
3	100	100	88	100	80
4	180	100	68	80	80
5	240	96	88	100	90
6	320	100	92	90	90
7	420	96	88	100	90
8	560	100	88	90	90
9	750	100	68	80	70
10	1,000[1]	100	76	100	100

[1]Copper concentration of 750 mg./kg. (dry mud) by laboratory analysis.

EXPERIMENT B

TEST JAR	COPPER CONCENTRATION mg./kg. (dry mud)	TENDIPES PLUMOSUS (25 in each jar)		PISIDIUM IDAHOENSE (15 in each jar)	
		Per cent survival 30 days	Per cent survival 60 days	Per cent survival 30 days	Per cent survival 60 days
1	Control	100	84	80	67
2	Control	96	80	100	100
3	240	100	92	80	80
4	320	100	88	80	80
5	560	92	92	100	100
6	870	92	100	73	60
7	1,000	92	88	80	67
8	1,350	100	100	80	73
9	1,550	100	96	87	80
10	1,800	100	96	93	87
11	2,400[1]	100	76	87	53
12	2,800[2]	100	84	100	100
13	3,200[3]	100	80	67	33

[1]Copper concentration of 2,000 mg./kg. (dry mud) by laboratory analysis.
[2]Copper concentration of 2,680 mg./kg. (dry mud) by laboratory analysis.
[3]Copper concentration of 2,500 mg./kg. (dry mud) by laboratory analysis.

basis, (Experiment A), an 80% survival was found in both the control and experimental jars. Similar results were obtained in an experiment containing copper concentrations of 2,700 milligrams per kilogram of mud on a dry-weight basis (Experiment B). A third experiment (C) was run with copper concentrations up to 21,000 milligrams per kilogram of mud on a dry-weight basis although it is not expected that one would encounter such a condition in the natural state. A severe mortality was encoun-

EXPERIMENT C

TEST JAR	COPPER CONCENTRATION BY LABORATORY ANALYSIS mg./kg. (dry mud)	TENDIPES PLUMOSUS (25 in each jar)		PISIDIUM IDAHOENSE (14 in each jar)	
		Per cent survival 30 days	Per cent survival 60 days*	Per cent survival 30 days	Per cent survival 60 days*
1	Control	100	56	72	72
2	Control	96	32	86	57
3	3,300	92	40	93	43
4	4,200	100	28	93	79
5	5,800	84	16	72	43
6	9,600	96	28	100	79
7	11,200	20	0	86	79
8	17,400	0	0	57	21
9	21,000	0	0	29	0

*Water was unavoidably discontinued in water baths with the result that temperatures rose beyond the limit of tolerance.

EXPERIMENT D

TEST JAR	BOTTOM MUD UTILIZED	TENDIPES PLUMOSUS (25 in each jar)		PISIDIUM IDAHOENSE (10 in each jar)	
		Per cent survival 30 days	Per cent survival 60 days	Per cent survival 30 days	Per cent survival 60 days
1	Beaver Dam Lake	100	76	100	60
2	Beaver Dam Lake	100	84	90	80
3	Pewaukee Lake	96	88	100	100
4	Pewaukee Lake	88	52	80	80
5	Nagawicka Lake	100	92	80	80
6	Nagawicka Lake	100	96	90	90
7	Delavan Lake	96	72	90	70
8	Delavan Lake	80	72	100	80
9	Lake Monona	92	72	70	70
10	Lake Monona	84	76	100	80
11	Lake Mendota	100	60	100	100
12	Lake Mendota	100	40	100	80

tered in the Chironomus larvae at the end of 30 days on the test jars containing 9,600 milligrams or more per kilogram of mud on a dry-weight basis. On the other hand, 79% of the fingernail clams were alive in the 11,200 milligram test jar at the end of 60 days, and 21% of the fingernail claims survived a concentration of 17,400 milligrams per kilogram of mud on a dry-weight basis for a period of 60 days.

In an effort to determine whether or not Lake Mendota organisms would survive in muds from other lakes under similar experimental conditions, these organisms were placed in bottom mud from six lakes (Experiment D) including Lake Monona with a copper content of 450 milligrams per kilogram of mud (dry weight). The 60-day survival rate was not indicative of any toxic quality in the Lake Monona mud.

CONCLUSIONS

1. Although the toxic limit of copper sulphate, precipitated and accumulated in bottom muds, upon certain types of bottom-dwelling organisms could not be accurately determined in the time allotted, laboratory tests indicate that it is near 9,000 parts per million copper on a dry-weight basis.
2. Results of these studies indicate that the accumulation of copper (Cu) in bottom muds, resulting from the use of copper sulphate to control algae in hard water lakes, is considerably lower in concentration than the amounts experimentally determined to have a deleterious effect on the profundal bottom-dwelling organisms studied.
3. From the results of these studies it is indicated that differences occurring in the population density of bottom organisms in the four lakes studied are due to ecological variables within these separate bodies of water.

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THE RELIGIOUS CONVICTIONS OF THE ABBÉ PRÉVOST

BERENICE COOPER
State College, Superior, Wisconsin

Information about the Abbé Prévost is limited even for the scholar, and for the average reader who is not curious about Ph.D. dissertations and the publications of learned societies, or who does not read French or German with ease, there is practically nothing.

Of course, opera-lovers are aware that the librettos of Puccini's *Manon* and of Massenet's *Manon Lescaut* are based upon a sentimental novel by Antoine François Prévost, and students of French literature know the abbé as an eighteenth-century novelist, who in addition to *Manon Lescaut,* wrote a number of long-winded and seldom-read romances and translated the novels of Richardson into French. Histories of French literature give a few pages to Prévost as a sentimental novelist and as a journalist who by his *Pour et Contre* sought to promote better Anglo–French relations in literature. Encyclopedias, except for the *Roman Catholic Encyclopedia,* give a brief sketch of his work and of his life.

But this scant recognition is accorded him only as a writer of romances, a translator, and a journalist. His contribution to the history of religious toleration and to the development of religious liberalism has been almost entirely ignored. Those few scholars who have written about Prévost in connection with the religious and philosophical controversies of his time, have connected him with Jansenism, partly on the basis of a few passages in *Manon Lescaut* and partly on the basis of his quarrels with the Jesuits.[1] All critical evaluations have failed to consider the more important evidence of his later work, *Le Philosophe anglais,*[2] and they

[1] For a discussion of arguments for Prévost's Jansenism, see Henri Harrisse, *La Vie monastique de l'abbe Prévost* (Paris: Le Clerc, 1903), pp. 25–29, 49–50; Paul Hazard, "Jansénisme", *Études critique sur Manon Lescaut* (Chicago: University of Chicago Press, 1924), pp. 47–69; Eugène Lasserre, *Manon Lescaut de l'abbé Prévost* (Paris: Société Française d'Editions Littéraires et Techniques, 1930), pp. 90–118; Andre de Maricourt, *Ce bon Abbé Prévost* (Paris: Hachette, 1932), pp. 101–09; Franz Pauli, *Die Philosophischen Grundanschauungen in den Romanen de Abbé Prévost, im besonderen Manon Lescaut* (Marburg: Ebel, 1912), pp. 13–92.

[2] It should be noted in justice to both Hazard and Lasserre that they have pointed out the fact that Prévost revised a passage on grace in the 1753 edition of *Manon Lescaut,* ten years after he had completed *Le Philosophe anglais,* and that Professor Hazard in his paper "Un romantique de 1730: l'abbé Prévost," *Harvard Tercentenary Publications: Authority and the Individual* (Cambridge: Harvard University Press. 1937), says, "Il hesite; quelquefois il est pour les accommodements qui rendent moins penible la voie du salut, comme les Jesuits;

have misinterpreted his quarrel with the Jesuits as indicating that he sympathized with their enemies.

A careful reading of *Le Philosophe anglais* will show that the satire of the Jesuits in this novel is a consistent part of a book which has for its purpose the exposure of narrow sectarianism, bigotry, and casuistic interpretation of dogma both Protestant and Catholic. Jansenists and Protestants come off no better than do Jesuits when judged by Cleveland's standards for what he designates as "true religion": that it must satisfy his reason, that it must be consistent with principles of love and justice toward fellow-men, and that it must furnish strength and comfort in time of sorrow.[3]

Since Prévost states in the preface to *Le Philosophe anglais* that his own opinions are identical with those of Cleveland,[4] this novel becomes important in any estimate of the author's character and religious convictions. Furthermore, it was written over a period of six or seven years when Prévost was resolving the conflict in his own mind, and although the first part was published soon after the publication of *Manon Lescaut,* the second part, containing the clear statement of Cleveland's religious views, was not published until 1738–39, four and five years after Prévost apparently had resolved the conflict in his own opinions.

To understand the significance of *Le Philosophe anglais* as an expression of the religious convictions of Prévost, one should first look at the relation of the writing and the publication of the novel to the story of the early life of the author. The biography of Antoine François Prévost d'Exiles is a drama of intense religious conflict finally resolved by reconciliation with the church and the order which exiled him.

His life from the age of sixteen until his twenty-third year was a stormy conflict between the world and the cloister. Twice he ran away to the army from his novitiate in the Society of Jesus. After the Jesuits had forgiven him and taken him back the second time, he decided to enter the Benedictine order. We have his own words for it that he took his vows with mental reservations which he felt justified his breaking them later.[5]

After seven years as a Benedictine in various houses of that order, the abbé was at Saint-Maur where the discipline was especially strict, and he applied for papal permission to transfer to

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quelquefois il pense, comme les Jansénistes . . ." p. 302. But Professor Hazard here as always when he writes of Prévost treats him as an instable person, not a serious thinker.

[3] *Le Philosophe anglais* (Rouen: Racine, 1785), V, vii, 4–15.

[4] *Ibid.* I, "Preface," ii.

[5] Letter to Dom Clement de la Rue, quoted by Harrisse, *L'abbé Prévost,* (Paris: Levy, 1896), p. 163.

the less rigid discipline of the house at Cluny.[6] Papal permission was slow in coming, although Prévost maintained that his superior deliberately kept the papal dispensation lying upon his desk after it arrived. Whatever may be the truth about that matter, the impatient Prévost fled to Holland and then to England, becoming for six years Prévost d'Exiles.

It was during his period of exile that he brought out the first four volumes of *Le Philosophe anglais ou histoire de Monsieur Cléveland, fils naturel de Cromwel, écrité par lui-meme, et traduite de l'anglois par l'auteur des Mémoires d'un homme de qualité.* The last four volumes were not published until 1738–39, after his return to the church in 1734, and the content of each of the two parts is related to the exile and to the reconciliation, if Prévost spoke sincerely in saying that his opinions agreed with Cleveland's.

This story of Mr. Cleveland Prévost attempted to represent as a true biography based upon a manuscript given him by Cleveland's son. He made so elaborate a pretense that he published an English translation of his French manuscript before the book came off the press.[7] But during the controversies provoked by the publication of *Cleveland,* as the book is often called, he forgot his elaborate pretense and began to defend his purpose in writing *Le Philosophe anglais.*

The four volumes of 1731–32 tell the story of Cleveland's being educated by his mother in the principles of moral philosophy and natural religion,[8] of the failure of this philosophy to endue his soul with strength sufficient to bear great sorrow, and of his disillusionment first with moral philosophy and natural religion and then with revealed religion as presented in turn by a Protestant minister, a Jansenist, and a Jesuit. No one of these representatives of organized religion comes off well during Cleveland's examination of what each group has to offer as a substitute for the views he has discarded.

Although Prévost is equally severe in his satire of the claims of each one, only the Jesuits seem to have expressed their resentment; the story of the exchange of letters with them is an inter-

[6] Harrisse says that friends urged him to apply for the transfer because the life at Cluny would permit him a kind of study suitable to his talents. *La Vie monastique de de l'abbé Prévost,* pp. 32–33.

[7] According to Professor George Sherburn, the book was reviewed as genuine memoirs in a magazine devoted exclusively to non-fiction, *Historia Litteraria,* II, 9 (March, 1731, 285–92). See Professor Sherburn's review of Mysie Robertson's edition of Prévost's *Memoires et avantures d'un homme de qualité, Modern Philology,* XXV (1927) 246–48.

[8] The teachings of Elizabeth Cleveland are always designated as moral philosophy, and Cleveland all through the eight volumes refers to his opinions in his youth as "my philosophy." But he teaches a tribe of American Indians a natural religion and states several times in the novel that he believes in a Supreme Being, in loving his fellow-men, and in treating them with justice and kindness.

esting episode.[9] Although the *Bibliothéque Belgique* lamented the deistical tendencies of the novel,[10] no protests from Jansenists or from Protestants are recorded in the material examined for this study.

The controversies about Prévost's satire of the Jesuits had scarcely died down before he became reconciled with the church and was received again into the Benedectine order with the stipulation that he perform a second novitiate. The remainder of his life was spent as an unattached abbé, most of the time as aumoner for Prince Conti. Apparently these obligations did not prevent his pursuing a literary career, for in addition to considerable translating, editing, and other literary work, he completed a novel, *Le Doyen du Killerine* and added four volumes to *Le Philosophe anglais*. It is in the preface to the 1738–39 volumes that he states that the purpose of the novel is to show that peace of mind can be found only through "true religion" and expresses surprise that any readers could feel that the book had done any harm to religion, and he explains at some length the plan of the book, that it shows the earlier views of Cleveland to be incomplete.[11]

The publication of these concluding volumes of Cleveland's story follows Prévost's resolution of the conflicts in his own religious life. His affirmation that the book represents his own views requires that any just estimate of his character take account of those volumes of *Le Philosophe anglais* which were published seven and eight years later than *Manon Lescaut* (1731) and which treat the conversion of Cleveland from a natural religion to a revealed religion.

The reader who will look beneath the superficialities that are typical of most eighteenth-century novels before 1740, can not fail to recognize that in *Le Philosophe anglais* the real theme is the conflict within the hero's mind between two philosophies of religious thought, naturalism and supernaturalism; and that the real action is not the shipwrecks, the wandering in the American wilderness, the political and love intrigues, the revenge and persecution episodes. These are only the backdrop for the drama of the evolution of the hero's progress from confidence in the power of moral philosophy and natural religion to a faith in a "true

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[9] Hazard, "Sur *Manon Lescaut*," *Etudes critiques*, pp. 59–63.

[10] October, 1732, pp. 419–50.

[11] This defense of the purpose of *Le Philosophe anglais* had already appeared as part of the preface to *Le Doyen Killerine* and when in 1738 Etienne Neaulme at Utrecht published volume six of *Le Philosophe anglais* (Neaulme's 1936 edition of the first part was five volumes instead of four) Prévost prefaced this continuation with an "Avertissement" incorporating the statement already published in the 1936 edition of *Le Doyen*.

religion" that reconciles the best of naturalism with the best of supernaturalism.

Cleveland's search throughout the long narrative is for peace of mind; the "true religion" which finally resolves all the conflicts in his intellectual and spiritual life is the outcome of a struggle in which the motivating forces are his experiences with the dominant philosophical and religious systems of the late seventeenth and the early eighteenth centuries.

Prévost's treatment of Cleveland's reactions to these controversial ideas is one of the best sources of information on his own religious convictions since he has asserted that his ideas agree with Cleveland's. To examine *Le Philosophe anglais* as such a source of information is the purpose of this paper.

Cleveland's mother taught him a moral philosophy akin to Neo-Stoicism: happiness may be attained through the right emotions and the right ideas and through the solid principles of virtue and the constant rules of wisdom and reason. To live by these principles means educating the heart as well as the mind for irregular impulses, or passions, must be controlled. Cleveland says that if we could have on this earth men without passions, we would have a society of happy persons.[12]

At one period in his early adventures, Cleveland lives among a friendly tribe of American Indians and teaches them a religion of nature similar to seventeenth-century Deism. It was this part of the book to which the reviewer in *Bibliothéque Belgique* took exception.

Throughout his youth Cleveland finds this moral philosophy and natural religion adequate as a source of inner strength. Cromwell's plots against his former mistress and her son, even the death of his mother, and a long series of misfortunes following that sad event do not shake the equanimity of Cleveland.

But when he is led by circumstantial evidence to believe that his beloved wife, Fanny, has eloped with his best friend, Gelin, Cleveland finds that moral philosophy has no comfort for him. He renounces it as sophism, an evil illusion, a false phantom which has failed to endue his soul with strength in time of greatest need. Re-examining his philosophy, he finds no logical flaws in it, but the fact remains that when the wound is to the tenderest affections of the human heart, moral philosophy has no consolation to offer; its power is limited. What Cleveland asks is a faith that can bring him comfort for sorrow and assure him peace of mind.

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[12] *Le Philosophe anglais*, I, i, 43.

After denouncing philosophy for its failure, Cleveland plunges into a period of despair so dark that he is about to commit suicide and also to kill his two little sons in order to save them from such a horrible world as this; but the pleas of the children weaken his resolution, and he again learns that the heart is more powerful than reason, for his suicide had seemed perfectly logical to him. The logic of suicide is supported by Cleveland's study of philosophy and constitutes another influence of Stoicism, since the Stoics approved suicide under certain circumstances. Cleveland also cites the examples of Cato, Demosthenes, Mithridates, and Mark Anthony as authority for suicide's being consistent with virtue and wisdom.

The household of Cleveland is so alarmed by this frustrated desire for suicide that two women, Mrs. Bridge and Mme. Lallin, beg him to listen to the consolations of religion. Having discarded his old philosophy and natural religion, Cleveland has nothing to lose by an examination into what revealed religion has to offer, and he agrees (since Mrs. Bridge is a Protestant and Mme. Lallin, a Catholic) to listen to Minister C., a Protestant clergyman, and Father Le Bane, a Roman Catholic priest, who holds Jansenist views as it later transpires. Finding that listening to them alternately confuses him, Cleveland decides to hear the Protestant entirely through first and then to hear the Catholic faith expounded.

The Protestant proves to be a bigoted, intolerant man, who presents religion so that it seems to Cleveland dark and forbidding. The doctrines Minister C. expounds do not agree with Cleveland's standards of love of fellowmen, justice, and reason.

Suddenly, before his conferences with Minister C. are concluded, Cleveland is served with a *lettre de cachet* and is taken to the house of the bishop of Angers, not as a prisoner, he is told, but as a guest; his children are put in a Catholic school and his niece in a convent. He learns that the Catholics, knowing that he was listening to a Protestant minister, think that his desire to receive religious instruction should be gratified, but that they wish him to receive sound instruction.

Cleveland happens to be an English citizen, and after demanding his rights and appealing to the king through the English-born Duchess Henriette, he is released.

Now if the Abbé Prévost had a strong Jansenist bias, it is impossible to think that he would use an episode like this, one in which the hero's vigorous resentment of his treatment by the Jansenist ecclesiastics might be interpreted as representing the author's opinion.[13]

[13] *Ibid.* V, vii, 21–22.

Neither can one argue on this basis that Prévost was partial to the Jesuits. One can sympathize with their objections to the characterization of Father Ruel, a Jesuit suggested by the Duchess Henriette as a good antidote for the sombre picture of religion given by Father Le Bane, the Jansenist.

Father Ruel advises Cleveland to fall in love as a means of curing his despair, and he introduces him to Cecile, with whom Cleveland does fall in love. This Jesuit is a casuist in religious philosophy and a treacherous intriguer; making use of information gathered in the confessional from Mme. Lallin, he plots against Cleveland's escape to England and from Roman Catholic influence.

But this episode in the story comes at the end of the volumes published in 1731–32, and the most important evidence of Prévost's religious convictions is found in that part of the novel that he completed after he had been reconciled with the church and the Benedictine order.

It is true that the Jesuits are treated with more consideration in the last four volumes. There are elaborate explanations in the preface regarding the use of a Jesuit as a character in the story. Cleveland visits his sons who are students in the Jesuit College de Louis-le-Grand, where they had been forcibly placed through Father Ruel's machinations. There Cleveland is impressed favorably with the Jesuits in charge, with the general conduct of the students, with the general atmosphere of the school, and with its prestige in France at a period when the order is being persecuted.[14]

Lord Clarendon, a Protestant, approves the college for the splendid training it gives, and makes a perhaps mildly satirical remark, that until children reach the age of reason and can think for themselves, it makes little difference what ideas of religion are presented to them.[15]

Father Ruel, killed during another misguided intrigue against Cleveland, repents and confesses that the motive for all he did was personal pride in making Cleveland a convert. Gelin, a once treacherous friend but now a convert and a Jesuit, becomes the devoted tutor of Cleveland's sons at the *College de Louis-le-Grand.*[16]

Cleveland's wife, with whom he is reunited after charges based upon circumstantial evidence have been refuted, becomes a devout Catholic, and her father confessor is characterized sym-

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[14] *Ibid.* VII, xii, 164.
[15] *Ibid.*
[16] *Ibid.* VIII, xv, 230.

pathetically by the author, although there are a few sly bits of good-humored satire about his zeal to make converts.[17] Ceçile, who has been discovered to be Cleveland's daughter lost in her infancy and mourned as dead, becomes a convert to Catholicism, although she has been reared a Protestant by her foster parents. Hers is a death-bed conversion. Cleveland respects the religion of his wife and envies her the consolation which she derives from it at the time of their mutual bereavement.

Still searching for peace of mind and a religion that will satisfy his reason as well as comfort his heart, Cleveland has made in the meantime a brief investigation of the philosophy of materialism as taught by Hobbes and kept alive in France by a group of *philosophes* whose experiments only convince Cleveland that it is best to recognize the limitations of human intelligence.[18]

Finally Cleveland's conversion to a fully satisfying faith is accomplished by Lord Clarendon, to whom he turns with the plea that this friend will not offer vague and uncertain suppositions but reveal in the attributes of the Sovereign-Being, or in man's nature, or in the ideas of reason and the nature of things, an appearance of proof, a quality of justice, a shade of truth that will reconcile the frightful contradictions of life.

Although he has envied Fanny the consolations of her religion, has discussed with her the relation of nature to grace, and has listened with approval to her sage comment, that the bonds of nature are not destroyed by the gift of grace, Cleveland seems never to have considered becoming a Catholic; and Fanny seems undisturbed by the fact that his conversion to "true religion" is accomplished by the exiled Lord Clarendon, noted for his persecution of Catholics during the period of his power in England.

If there is any truth in the story, reported by Professor Harrisse, that Chancellor Aguesseau permitted the printing of *Le Philosophe anglais* in France only upon the condition that Cleveland be converted to Catholicism in the last volume,[19] the Chancellor can not have read the book, for while Cleveland's views might be accepted as orthodox Catholicism as far as they go, they omit many doctrines fundamental in Catholicism, and the book contains a spirited plea for the breaking down of sectarian divisions because these controversies do the cause of true religion great harm.[20]

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[17] *Ibid.* VII, xii, 187.
[18] *Ibid.* VIII, xv, 53–67.
[19] *Ibid.* 203.
[20] *Le Philosophe anglais* in *Oeuvres Choises* (Amsterdam and Paris: Serpente, 1783) IV, 430. This passage was deleted from all editions published at Amsterdam and Rouen from 1757–85.

One of the most obvious omissions of fundamental Catholic dogma in Cleveland's full statement of his religious views, is that Christ is never mentioned, nor is salvation through acceptance of His vicarious sacrifice. The statement could easily be a Unitarian creed. Neither is there any mention of the Virgin Mary and the Immaculate Conception. There is no talk of sin, of confession, and of repentance.

Another notable characteristic of Cleveland's conversion is that no minister or priest has any part in it and that there is no recognition in any manner of a church or any organized religious group. Cleveland is converted by a layman who expounds to him a religion that reconciles natural and supernatural religion and that includes may views similar to those of Neo-Stoic Christians and Latitudinarians of the late seventeenth and early eighteenth centuries.

The best that is offered by natural religion and by the moral philosophy taught to Cleveland by his mother, is recognized as an anticipation of the tranquil mind which can be attained only through religion, for although the law of grace does not deny the natural law, nature alone is insufficient and must be supplemented by supernatural grace.[21]

This "true religion" meets all the tests of reason and overcomes Cleveland's objections to Minister C.'s Protestantism, Father LeBane's Jansenism, and Father Ruel's interpretations of religion.

The ethical principles to which Cleveland has subscribed all his life, and without which no religion can appeal to him, are fundamental in this "true religion": justice, moderation, and toleration. Dogmatism, narrow sectarianism, and persecution of groups holding opposite religious views are irrational and do harm to religion.

Asceticism and enthusiasm are equally inconsistent with "true religion." Here Cleveland seems to be opposing both the cloistered orders of the Catholic church and the fanatical evangelistic spirit of much Protestantism.

What, then, are we entitled to conclude regarding the religious convictions of the Abbé Prévost? His prefatory statement that the views of Mr. Cleveland agree with his own and the fact that the book containing the final statement of Cleveland's faith was published four years after the Abbé's reconciliation with the Catholic church and the Benedictine order, justify the conclusion that the religious convictions of Prévost were exceptionally lib-

[21] The story of Cleveland's conversion may be found in the Rouen edition, 1785, VII, xii, 135–40; VIII, xv, 202–215.

eral for a man of his affiliations, since they place no emphasis upon the church as an institution through which men find God.

Religion appears to be for the Abbé Prévost a private affair. No peace of mind has come to Cleveland through the authority of the church or through its representatives. He has lived and searched for a faith that satisfies his reason. He has learned the limitations of human intelligence, that man lives not alone by his head but must live also by his heart, that he is not strong enough through his own nature to bear the sorrows of life or to reconcile the contradictory claims of head and heart, or to control his passions wisely, that he needs the aid of divine grace to supplement the resources of his own intelligence.

In these ideas of the power of the passions to cause human misery and the need to control them by reason, in the emphasis upon ethical living as more important than dogma, and in the affirmation of belief in a Supreme Being, who may be discovered in the operations of natural law, there is the influence of both Neo-Stoicism and Deism; in the emphasis upon Christian unity through recognition of beliefs that are common to all faiths, there is the influence of the Latitudinarianism of the Age of Reason; and in the synthesis of all these ideas of the early eighteenth century lies the unique contribution of the Abbé Prévost.

Certainly these views are not orthodox Catholicism, for they omit too much vital Catholic doctrine; they are not identical with those of natural religion or any of the forms of Deism, for they recognize the supernatural and revelation.

But does not the treatment of the theme of *Le Philosophe anglais* merit for the Abbé Prévost recognition as a man who in his own way solved the conflict among the religious ideas of his period?

At least, the sentimental romanticism of *Manon Lescaut,* effective as it is of its kind, fails to represent the mature Prévost, the eighteenth-century religious liberal, who has synthesized the best of pagan philosophy with the best of Christian and who reconciled in his own thinking naturalism and supernaturalism in religion.

As modern criticism re-examines and re-evaluates other long accepted estimates of literary men, it is time to compare the work of the mature Prévost with the work of his romantic immaturity and to realize that after the writing of *Manon Lescaut* there is another Prévost.

I am ready to concede that *Le Philosophe anglais* is cluttered with too much melodrama of the popular eighteenth-century plot, that the style of *Manon Lescaut* rises to emotional heights not reached in *Le Philosophe anglais,* that as far as technique of writing the novel is concerned, *Manon Lescaut* is superior; but there is another basis of evaluation by which *Le Philosophe anglais* is superior to *Manon Lescaut,* an estimate based upon the universal significance of the theme, the contribution of that theme to the history of ideas, and the value of the book as a spiritual biography of an eighteenth-century liberal.

Perhaps it is unfortunate that Prévost chose to bury in an eight-volume novel the story of the development of Cleveland's religious opinions, but perhaps discretion dictated this disguise, since the opinions which are so far from being consistent with the author's religious affiliations, receive the Abbé's endorsement in the preface to *Le Philosophe anglais.*

THE BIRTH AND DEVELOPMENT OF GROUND-WATER HYDROLOGY—A HISTORICAL SUMMARY

JAMES E. HACKETT
Department of Geology, University of Wisconsin

ABSTRACT

Basic to the science of ground-water hydrology are the following: (1) replenishment of underground water by precipitation and infiltration; (2) the fundamental principles of geologic occurrence; (3) the understanding of the physics of underground-water movement. The historical development of these three fundamental concepts is traced and their intergration into the science of ground-water hydrology is described.

INTRODUCTION

More than 50 years ago, Archibald Geikie (1897), one of the great figures of natural science in the nineteenth century, wrote, "In science, as in all other departments of human knowledge and inquiry, no thorough grasp of a subject can be gained, unless the history of its development is clearly appreciated."

This paper is a review of the birth and development of the science of ground-water hydrology—that science which deals with the occurrence and movement of underground water. This summary makes no pretense of adding to the historical data which have been ably recounted by several other authors.[1] Rather, it is concerned only with the basic concepts of the science, their development from earliest times to the present, and their integration into the present science of ground-water hydrology.

It is hoped that this brief survey will, in the words of Geikie (1897), give some perspective to those who "while eagerly pressing forward in the search after the secrets of nature, are apt to keep the eye too constantly fixed on the way that has to be travelled, and to lose sight and remembrance of the paths already trodden."

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[1] The excellent historical treatments of Adams (1938), Baker and Horton (1936), and Meinzer (1934), (1942) furnished the historical data outlined in the following discussion. The reader interested in original sources is referred to the comprehensive references given in these papers.

Basic Concepts

The science of ground-water hydrology is based on three fundamental concepts. They can be stated as follows: (1) underground water originates when moisture precipitated from the atmosphere soaks into the ground; (2) the rocks in the upper crust of the earth are the receptacles, the reservoirs, containing underground water. Their nature controls the occurrence of subsurface water; and (3) movement of underground water obeys certain physical laws.

These three concepts are relatively simple. Geologist and layman alike accept them. But the evolution of the concepts has been a long one. They have become firmly established only after generations of work. With their establishment the science of ground-water hydrology has come of age. By tracing the development of each of the three concepts, the slow growth of the science to its present status may be best understood.

Origin of Underground Water

The first concept to be developed was that underground water forms eventually from rainfall. We now believe that water is transferred to the atmosphere by evaporation, is then delivered to the ground by precipitation, and a portion then seeps into the ground to replenish our underground-water supplies. However, this modern concept of the hydrologic cycle is opposite to the theory generally held up to the late eighteenth century. Prior to the late eighteenth century, the rainfall, or pluvial cycle, was not generally accepted because of two false assumptions. They were: (1) there was not enough rainfall to supply all the underground water, and (2) rainfall could not soak through the apparently impermeable surface of the earth.

The original hydrologic cycle was first stated by the Greek philosophers to explain the origin of springs and rivers. They believed that the water supplying the springs and rivers was contained in one or many subterranean caverns. Two main hypotheses were developed by the first century A.D. to account for the replenishment of these subterranean caverns. The hypotheses were: (1) water was conducted from the sea through subterranean channels below the mountains. It was then purified and raised to springs; and (2) the subterranean atmosphere, and perhaps the earth itself, were condensed into moisture in the caverns under the mountains. Note that neither explanation called for rainfall as the prime source of underground water. Rainfall was discarded because it was not believed to be adequate in amount nor able to penetrate through the earth's surface.

During the Dark Ages the subject of the origin of underground water was almost completely neglected. The subject became of general interest again with the coming of the Middle Ages. During the Middle Ages the view of the church was regarded as paramount on all questions. The hydrologic cycle approved by the church was the old Greek theory that the water originated in the sea and was transported landward by some subterranean route. The writers and scholars of the Middle Ages accepted this explanation. It was heresy to doubt it.

But those accepting the subterranean return of sea water to account for underground water were confronted with two problems. These were: (1) the necessity of eliminating salt from the sea water by either distillation or filtration, and (2) the elevation of the water from the level of the sea to the level of the springs and rivers. By the latter part of the seventeenth century, it was recognized that salt could not be filtered out but could be removed by distillation. The most popular theory of the time stated that sea water made its way into the interior of the earth to encounter a central fire. There the water was evaporated and steamed up through the earth's crust to the mountain tops. The salt was left behind in the rock through which the steam had passed.

When, however, the new scientific method was applied to the problem of the origin of underground water, the true hydrologic cycle became apparent. Quantitative experimental work in the latter part of the seventeenth century provided the basis for the rejection of the old subterranean hydrologic cycle. The experimental work of two Frenchmen, Perrault and Mariotte, proved false the assumptions that had led to the acceptance of the subterranean hydrologic cycle. These assumptions were: (1) rainfall was not adequate to supply the underground reservoirs, and (2) the surface of the earth was too impermeable to allow passage of moisture.

Pierre Perrault, in 1674, presented the results of the first serious attempt to actually measure rainfall and determine its relation to the amount of water carried off by the rivers. He made measurements of rainfall over a three-year period in the Seine River basin above a point in Burgundy. He then roughly estimated the area of the basin and the run-off from the basin. He was able to demonstrate that the quantity of water that fell on the basin as rain or snow was about six times the quantity of water discharged by the rivers. Perrault thereby proved that rainfall was adequate to account for the discharge of springs and rivers.

At about this same time, the French physicist, Mariotte, made more exact studies of discharge in the Seine River basin. His publications, appearing after his death in 1684, essentially verified Perrault's conclusions. Mariotte further demonstrated, by experimentation at the Paris Observatory, that seepage through the earth cover compared with the amount of rainfall. He also demonstrated the increase in the flow of springs during rainy weather and the decrease during time of drought. It was then evident that the earth did permit the penetration of moisture.

The observations of Perrault and Mariotte laid the foundation for further investigation which greatly strengthened the evidence in favor of the rainfall-infiltration concept. As a result, the hydrologic literature from the last quarter of the seventeenth century, through the eighteenth century, and into the early part of the nineteenth century consisted mainly of a defense of the old subterranean cycle against the pluvial or rainfall cycle. The outcome of the controversy saw the pluvial cycle almost universally accepted among scientists by the first part of the nineteenth century. In 1791, the basic features of the modern concept of the hydrologic cycle were presented by La Metherie. He explained that a part of the water from rain and snow consists of run-off across the land surface. A second part is held in the soil, later to feed the plants or to evaporate. A third part penetrates to reservoirs at greater depths from which it may gradually issue as springs.

It required over 2,000 years to develop the concept that underground water is recharged, replenished, by the seepage of rainfall into the ground. Compared to this, the development of the other two basic concepts and the consequent establishment of the science of ground-water hydrology was rapid. The basic concepts yet to be developed were: (1) the geologic control of the occurrence of underground water, and (2) the physical law controlling underground-water movement.

Occurrence of Underground Water

Underground water is strictly controlled by the nature of the rock in which it is contained. Therefore, the understanding of the occurrence of underground water required the understanding of the basic principles of geology. The fundamental principles of geology were established about the beginning of the nineteenth century. The way was then open for the study of the basically geologic problems of the occurrence and movement of underground water.

French engineers, geologists, and well drillers were especially active in the study. This was largely due to an intense interest in artesian conditions and in drilling artesian wells in France during the first half of the nineteenth century. A large number of publications appeared based on extensive research in different phases of the subject. As a result, the basic principles of the geologic occurrence of underground water and the hydrostatic theory of artesian flow were well established by the middle of the nineteenth century.

Movement of Underground Water

The basic principle governing the movement of underground water through water-bearing materials was recognized and described by the French hydraulic engineer, Henri Darcy. His publication in 1856 gave the results of a series of experiments on the flow of water in sands. His conclusions were expressed in a formula now known as Darcy's Law. The law governs the relation between velocity of percolation, permeability of water-bearing materials, and the hydraulic gradient of free or confined water. Darcy's classical work marks the final step in the establishment of the science of ground-water hydrology.

Development of Ground-Water Hydrology

Much of the work by European engineers and geologists during the last two or three decades of the nineteenth century and into the twentieth century was devoted to the study of ground-water hydrology in connection with the development of water supplies for public waterworks and other uses. In 1906 Gunther Thiem, a German hydrologist, established the basis for modern quantitative field studies. He developed a field method for determining permeability and rate of flow from pumping tests and the resultant drawdown in observation wells.

But it is in the United States that we have realized the fullest development of the science of ground-water hydrology. It is here that the practical applications of the principles of the science have been most widely made. Systematic quantitative methods of investigation have been developed to attack the problems of underground-water supply and recovery. These methods have been developed by the United States Geological Survey, particularly, and by many state geological surveys and other governmental units.

Summary and Conclusion

The science of ground-water hydrology is less than one hundred years old. But the development of its fundamental concepts had taken well over two thousand years. The concepts are: (1) underground water originates when moisture precipitated from the atmosphere soaks into the ground; (2) the rocks in the upper crust of the earth are the reservoirs containing underground water and their nature controls the occurrence of the subsurface water; (3) movement of underground water obeys certain physical laws.

It is the development of these concepts and the consequent establishment of the science of ground-water hydrology that has permitted the successful solution of practical problems of underground-water recovery and conservation.

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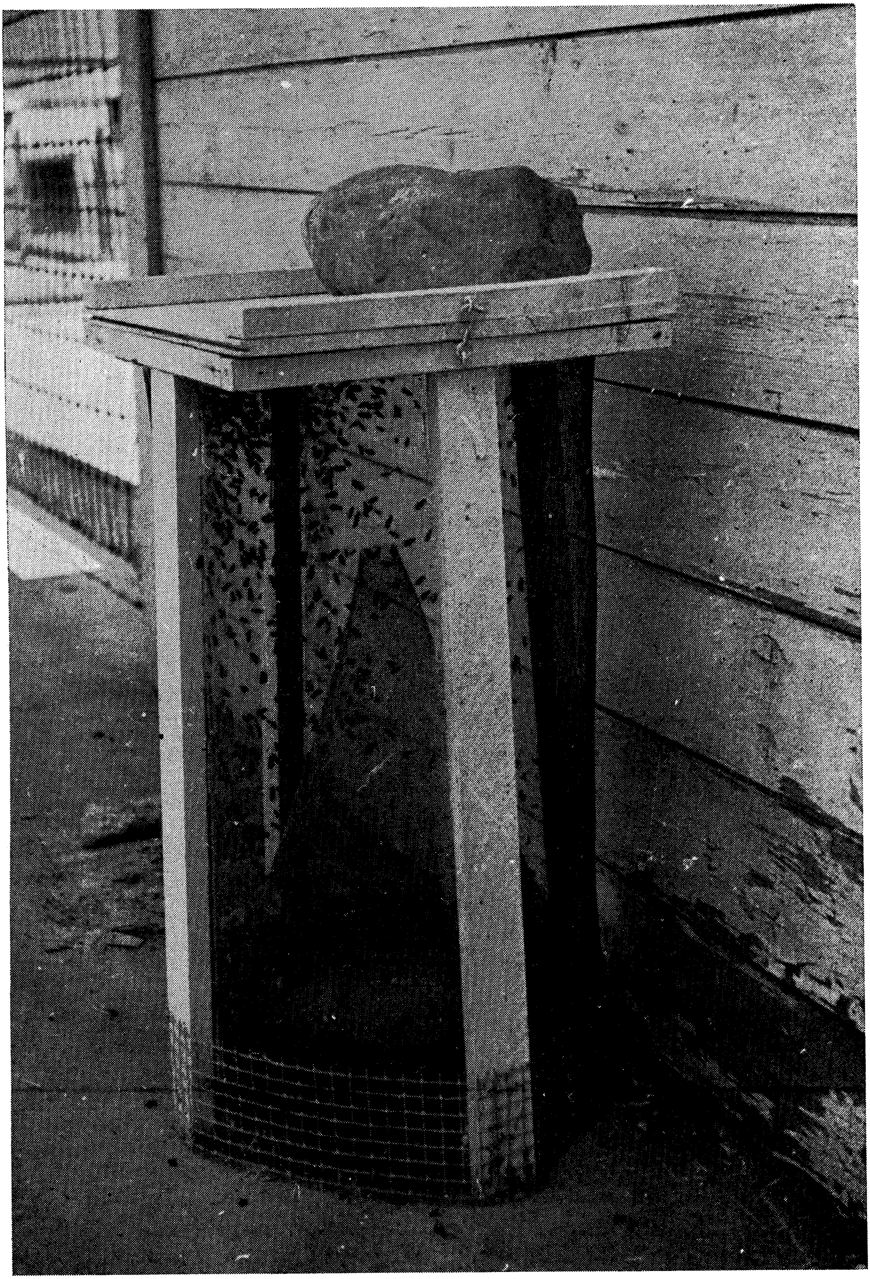

FIG. 1. Cylindrical cone-trap employed in blowfly collections.

THE SEASONAL INCIDENCE OF BLOWFLIES AT MADISON, WISCONSIN (DIPTERA-CALLIPHORIDAE)[1]

ROBERT J. DICKE AND JOHN P. EASTWOOD
University of Wisconsin

Very little information is available on the biology, distribution, and seasonal incidence of blowflies in Wisconsin. These flies, however, are of considerable economic importance to the animal industries of the State. Blowflies occur abundantly in a variety of domestic situations, and on farms are commonly associated with dairy cattle, sheep and swine. The adults of all species feed on, or are at least attracted to, carrion. With the exception of the cluster fly, *Pollenia rudis* (Fab.), the maggots of Calliphorids are generally saphrophytic in feeding habit and most commonly breed in decaying animal tissue. Invasions of blowfly maggots into the necrotic wounds and diseased tissues of domestic animals are frequently observed, and parasitic myiasis (sheep strike) is known to occur in Wisconsin sheep. These breeding habits would suggest that blowflies may serve as vectors of animal diseases and as an important source of food contamination. A study of blowflies indigenous to Wisconsin was initiated during the years 1949 and 1950 by trapping flies in the vicinity of Madison, Wisconsin.

Procedure: Blowflies were collected in baited cylindrical cone-traps (Fig. 1). The traps were two feet high by one foot in diameter, and were covered with 16-mesh wire screen. An inner wire screen cone 18 inches high with an opening one inch in diameter at the apex was attached to the base of the screen cylinder. The top of the cylinder was fitted with a removable wooden plate. Four strips of wood attached to the screened sides served as supports raising the base of the cage two inches above ground level. A strip of 4-mesh wire screen attached at the base served to exclude rodents. Flies attracted to a carrion bait placed under the screen cone entered through the openings at the base of the cylinder and eventually worked their way upward through the opening at the apex of the cone and into the trap proper. Trapped flies were readily removed through the top of the cage. The carcasses of four white rats placed at the base of the trap

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served as the attractant. All of the traps were in continuous operation. Flies were collected and the baits replaced at weekly intervals.

Ten traps were maintained from March 29 to December 27 for both years. Collection sites were as follows:

1. Genetics Building, on University campus.
2. Stock Pavilion, on University campus.
3. Hog Barn, on University campus.
4. Fur Farm, on University campus.
5. Sheep Barn, East Hill Farms, 1 mile west of Madison.
6. Loose-housing or Pen Barn, East Hill Farms, 1 mile west of Madison.
7. Gugel Farm, 7 miles west of Madison.
8. An abattoir in the vicinity of Madison.
9. University Arboretum at maintainance buildings.
10. State Fish Hatchery, 4 miles south of Madison.

No active breeding of blowflies in carrion occurred at any of the collection sites. General sanitation in respect to fly attraction appeared to be satisfactory at the Arboretum and Fish Hatchery. Discarded experimental animals held in waste receptacles for periods of two days before collection were the principal sources of attraction at the Genetics Building and Stock Pavilion. Large numbers of blowflies were observed hovering over animals and excrement at all of the remaining collection sites.

Results: Fourteen species of blowflies were collected. Actual counts of trap collections are summarized in Table 1 with species listed according to their relative abundance. The most common species collected was *Phormia regina* (Meigen) representing 51.05 per cent of the total collection for 1949 and 41.80 per cent for 1950. *Lucilia illustris* (Meigen), *Phaenicia sericata* (Meigen) and *Protophormia terrae-novae* (Robineau–Desvoidy) were next in abundance although the total collection of all three of these species was less than that of *P. regina.* Maximum collections were less than 5 per cent of the total for *Bufolucilia silvarum* (Meigen) and *Cynomyopsis cadaverina* (Robineau–Desvoidy), and less than 2 per cent for *Calliphora vicina* Robineau–Desvoidy and *Pollenia rudis* (Fab.). The total collections of *Phaenicia caeruleiviridis* (Macquart), *Calliphora vomitoria* (Linn.), *Calliphora livida* Hall, *Callitroga macellaria* (Fab.), and *Calliphora terrae-novae* Macquart represented less than 1 per cent of the total collection in 1949 and less than 2 per cent in 1950. *Eucalliphora lilaea* (Walker) was rare with only 12 specimens collected for the entire 1950 season.

The total blowfly catch for 1950 (263,992 flies) was only 61.4 per cent that of the total catch for 1949 (429,511 flies). This

TABLE 1

Summary of Blowfly Trap Collections at Biweekly Intervals

Species	Year	Collection on Week Ending—																Total Collection	
		Mar. 31	April 15	April 30	May 15	May 31	June 15	June 30	July 15	July 31	Aug. 15	Aug. 31	Sept. 15	Sept. 30	Oct. 15	Oct. 31	Nov 15	Number	Per cent
Phormia regina	1949	0	0	12	3,235	2,590	19,008	26,380	21,566	15,464	6,972	6,114	519	317	640	103	5	219,259	51.05
	1950	2	1	7	154	482	9,361	7,213	10,163	13,800	9,530	3,096	5,530	461	62	181	3	110,341	41.80
Lucilia illustris	1949	0	0	0	608	1,127	3,117	1,539	5,972	5,276	1,418	1,009	586	458	205	110	3	40,479	9.42
	1950	0	0	0	4	1,103	6,618	2,942	4,124	6,412	3,676	1,936	2,013	2,362	158	2,048	8	71,500	27.08
Phaenicia sericata	1949	0	0	2	1,586	1,308	2,588	2,967	4,008	8,316	5,754	5,305	1,310	1,445	1,224	322	4	71,986	16.76
	1950	0	1	3	5	63	389	465	564	1,101	1,961	2,769	5,632	1,900	81	508	2	29,898	11.32
Protophormia terrae-novae	1949	0	0	2	566	2,781	4,370	3,757	13,706	5,739	1,217	224	80	37	4	13	2	73,012	17.00
	1950	0	0	6	17	47	1,583	4,978	1,200	1,116	627	48	387	4	0	4	0	19,298	7.31
Bufolucilia silvarum	1949	0	0	0	40	489	315	900	1,898	375	73	24	49	23	20	0	0	7,670	1.79
	1950	0	0	0	0	148	1,165	581	888	624	466	360	308	233	33	154	4	11,253	4.26
Cynomyopsis cadaverina	1949	0	0	835	648	275	150	5	0	72	0	0	12	310	325	284	145	6,249	1.46
	1950	1	13	171	1,275	380	208	89	12	1	0	0	66	552	253	821	21	8,394	3.18
Calliphora vicina	1949	0	0	47	256	330	464	361	295	263	189	26	105	97	114	53	184	4,899	1.14
	1950	0	1	3	25	66	237	86	179	136	53	129	151	92	36	100	23	3,293	1.25
Pollenia rudis	1949	0	0	0	0	0	224	18	36	14	107	128	15	1	0	5	0	1,804	0.42
	1950	51	28	28	16	0	96	192	116	1,227	485	129	61	0	0	3	0	5,356	2.03
Phaenicia caeruleiviridis	1949	0	0	0	0	1	0	50	16	192	157	43	40	47	24	18	0	1,104	0.26
	1950	0	0	0	0	0	0	38	104	421	104	113	88	91	11	54	1	2,100	0.80
Calliphora vomitoria	1949	0	0	0	27	107	455	2	4	28	53	43	52	37	135	67	7	1,730	0.40
	1950	0	0	0	4	4	169	50	44	4	14	9	29	57	6	452	0	1,469	0.56
Calliphora livida	1949	0	0	39	37	17	106	8	0	0	1	1	0	5	0	2	0	430	0.10
	1950	0	0	17	141	33	0	8	30	4	0	0	0	11	3	18	0	685	0.26
Callitroga macellaria	1949	0	0	0	0	0	0	0	10	16	55	91	20	6	19	1	0	634	0.15
	1950	0	0	0	0	0	0	0	1	11	13	5	1	1	0	1	0	78	0.03
Calliphora terrae-novae	1949	0	0	4	11	7	1	4	0	0	2	0	18	12	29	20	5	235	0.05
	1950	0	0	1	11	18	0	0	2	0	0	0	0	15	6	117	0	315	0.12
Eucalliphora lilaea	1950	0	0	0	0	1	0	0	2	2	0	0	0	0	0	2	0	12	0.01
Total Collection	1949	0	0	941	7,014	9,032	31,158	35,991	47,511	35,755	15,998	13,008	2,878	2,795	2,779	998	355	429,511	
	1950	54	44	236	1,652	2,345	19,826	16,642	17,429	34,859	16,929	8,594	14,266	5,779	649	4,461	62	263,992	

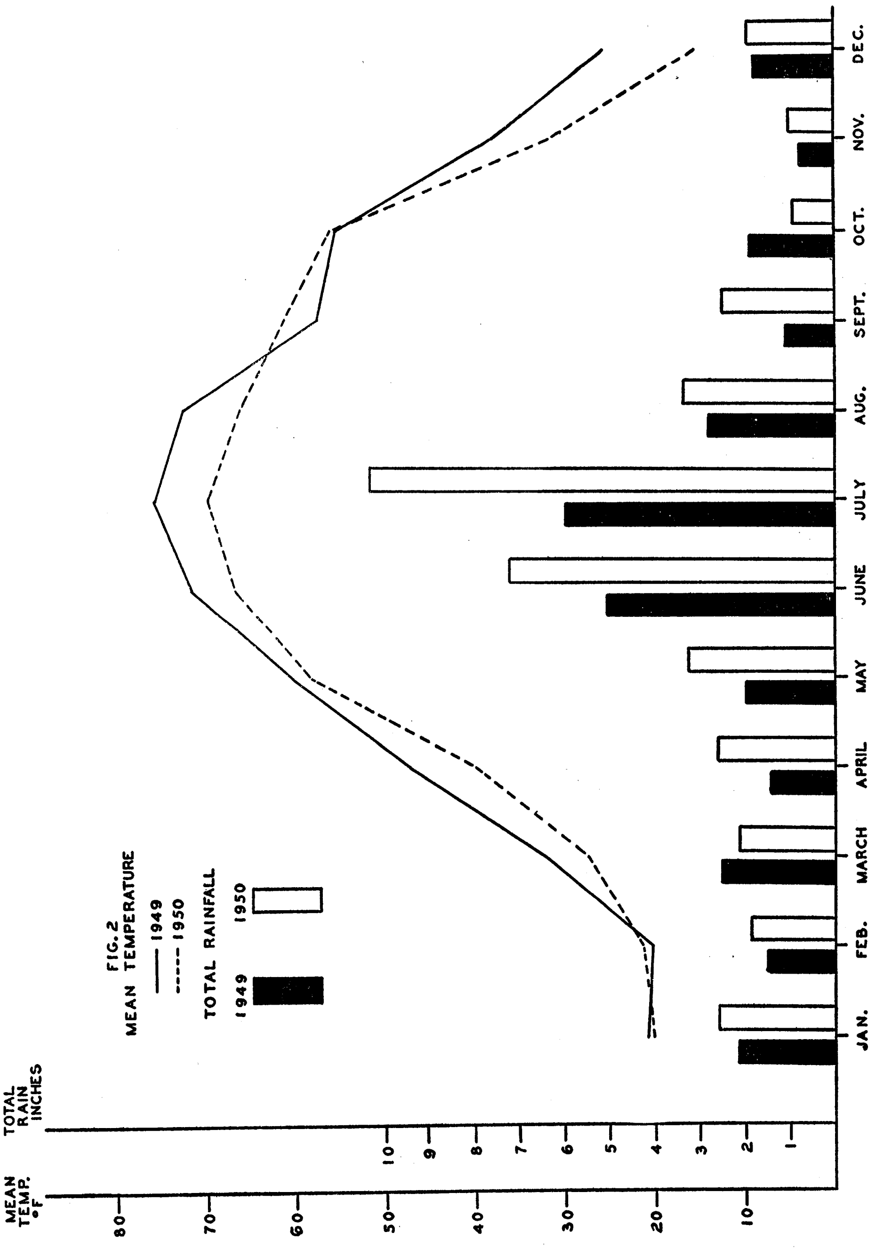
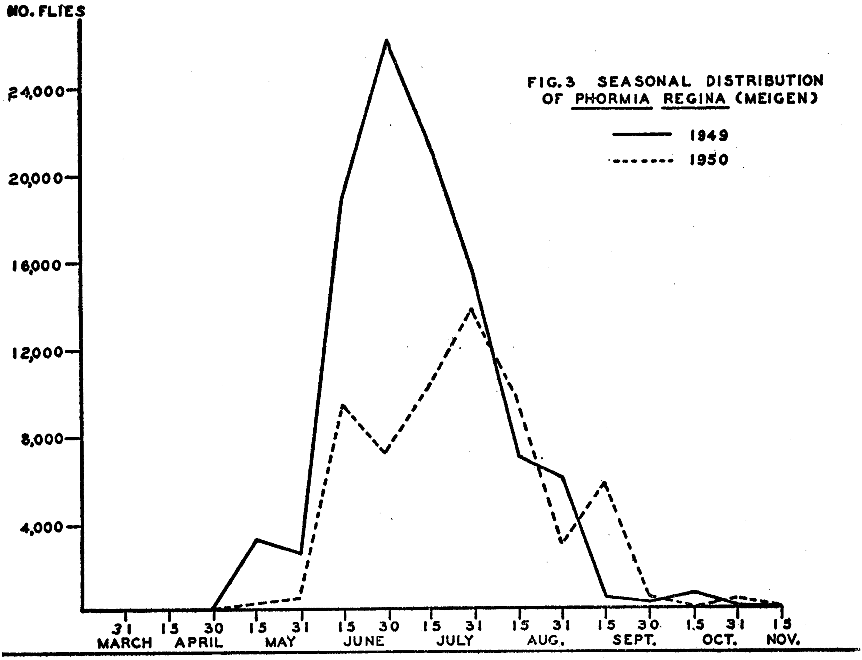


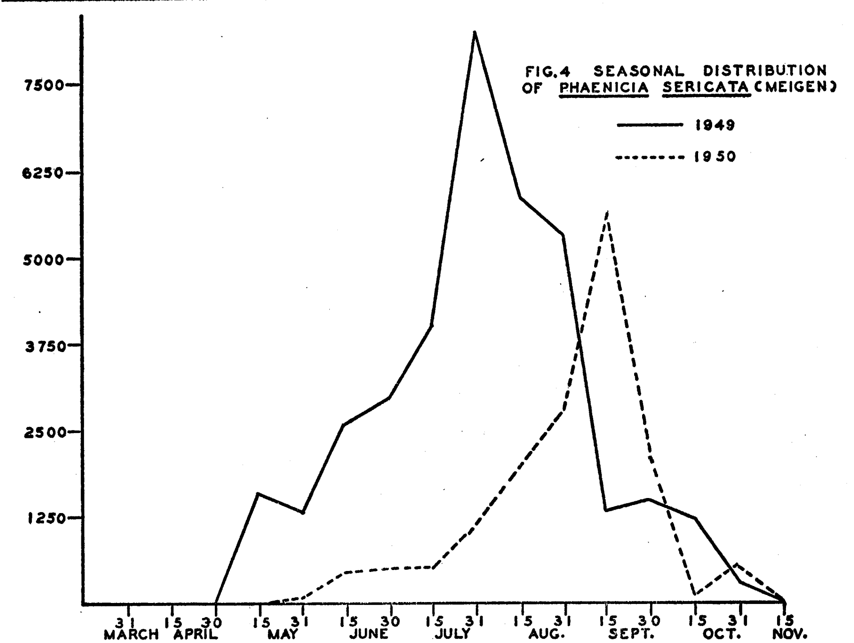
FIG. 2
MEAN TEMPERATURE
1949
1950
TOTAL RAINFALL
1949
1950
MEAN TEMP. °F
TOTAL RAIN INCHES
80
70
60
50
40
30
20
10
10
9
8
7
6
5
4
3
2
1
JAN.
FEB.
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.

difference in total collections may be a reflection of comparative weather conditions for the two years (Fig. 2). During April through August of 1950 the mean temperature averaged 5.3° F. below the mean for 1949. In May the mean temperature was 7.5° F. below that of 1949, and 6° F. below for July and August. Trap collections were only ¼ of the 1949 catch during the month of May, and approximately ½ during June and the early part of July. During the month of September the mean temperature for 1950 was 3.5° F. above that of the mean for 1949. This relatively warmer month reflected an increased catch in 1950 that was from four to two times that of 1949 (total catches for September 15 and 30 respectively). During the period April through October, the total precipitation in 1949 was 21.30 inches compared with 30.25 inches in 1950. The combination of a comparatively cool, wet spring and summer may have been adverse to several of the more abundant species of blowflies.

Total catches were significantly less in 1950 than in 1949 for *P. regina* (Fig. 3), *P. sericata* (Fig. 4), and *P. terrae-novae* (Fig. 5). Collections for *P. regina* in 1950 were only one-half that of 1949, while collections of *P. terrae-novae* were only 26.4 per cent that of 1949. The peak abundance of *P. sericata* was shifted from July 31 in 1949 to August 15 in 1950, along with a reduction of 58 per cent of the 1949 catch. These species apparently are more prevalent during the warm summer months, and the cooler weather occurring during the spring and summer of 1950 may account for these differences in trap catches.

Total collections of *C. cadaverina* (Fig. 6) were increased in 1950 by 34.3 per cent. This species appears to prefer cool weather since it is most abundant during early spring and late fall, with a marked reduction in numbers during June, July and August. *L. illustris* (Fig. 7) was more abundant during 1950 with an increased catch of 76.6 per cent. The seasonal occurrence of this species is difficult to interpret on the basis of comparative weather conditions. Two population peaks occurred during spring and early summer for both years, with greatest numbers collected during the comparatively cooler weather of 1950. Two additional peaks, however, occurred during the comparatively warmer fall of 1950. *P. rudis* was also more abundant during 1950. The larvae of this species, unlike all of the other Calliphoridae collected in this study, do not breed in carrion but are parasitic on earthworms. The relatively greater precipitation in 1950 (3.75 inches more rainfall during April, May and June) may have resulted in a greater availability or abundance of earthworms for parasitism.


NO. FLIES
24,000
20,000
16,000
12,000
8,000
4,000
FIG. 3 SEASONAL DISTRIBUTION OF PHORMIA REGINA (MEIGEN)
1949
1950
31 MARCH
15 30 APRIL
15 31 MAY
15 30 JUNE
15 31 JULY
15 31 AUG.
15 30 SEPT.
15 31 OCT.
15 NOV.


7500
6250
5000
3750
2500
1250
FIG. 4 SEASONAL DISTRIBUTION OF PHAENICIA SERICATA (MEIGEN)
1949
1950
31 MARCH
15 30 APRIL
15 31 MAY
15 30 JUNE
15 31 JULY
15 31 AUG.
15 30 SEPT.
15 31 OCT.
15 NOV.

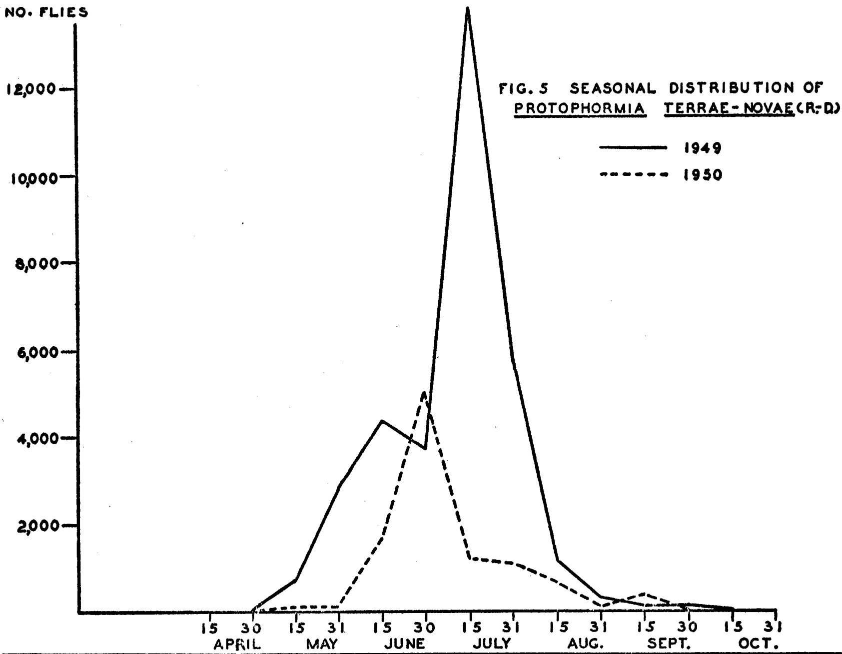


FIG. 5 SEASONAL DISTRIBUTION OF PROTOPHORMIA TERRAE-NOVAE (R.-D.)

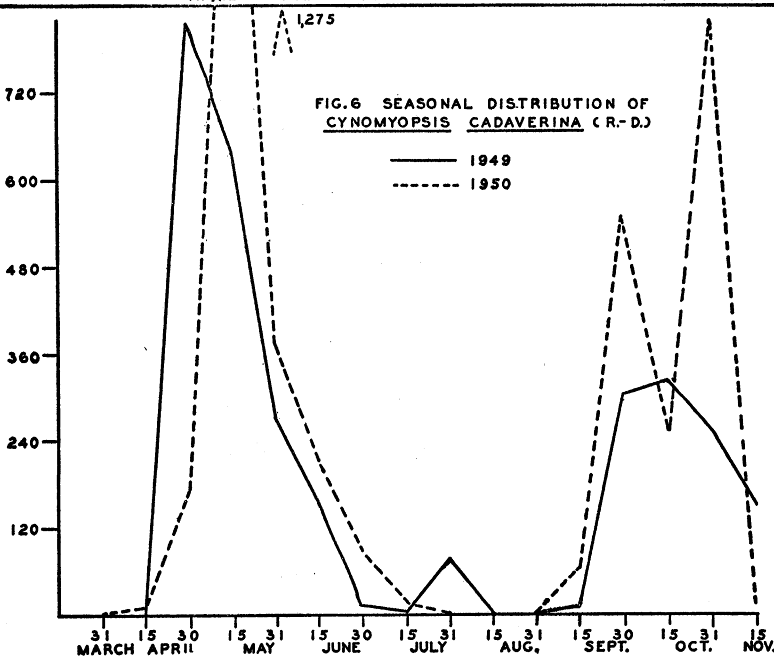


FIG. 6 SEASONAL DISTRIBUTION OF CYNOMYOPSIS CADAVERINA (R.-D.)

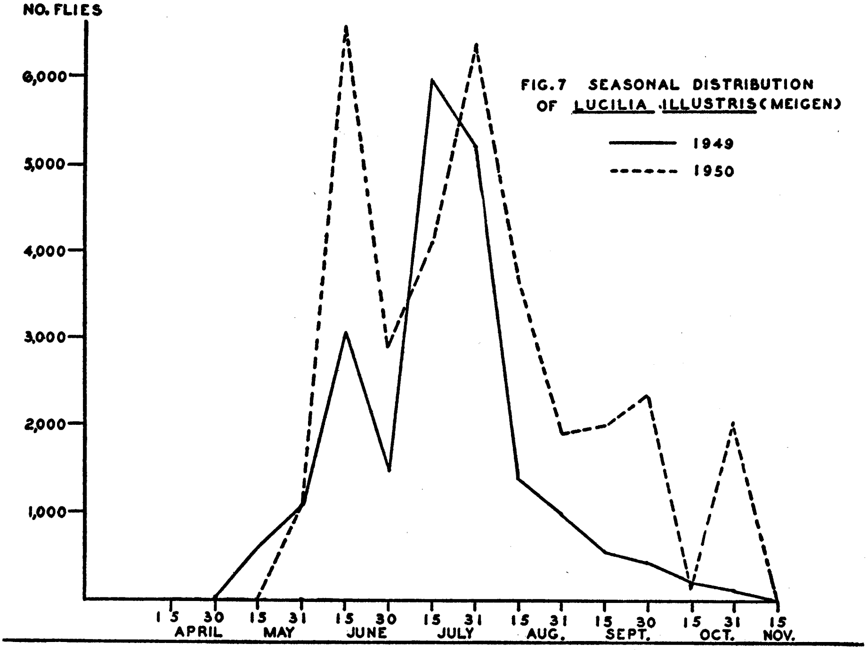


FIG. 7 SEASONAL DISTRIBUTION OF LUCILIA ILLUSTRIS (MEIGEN)

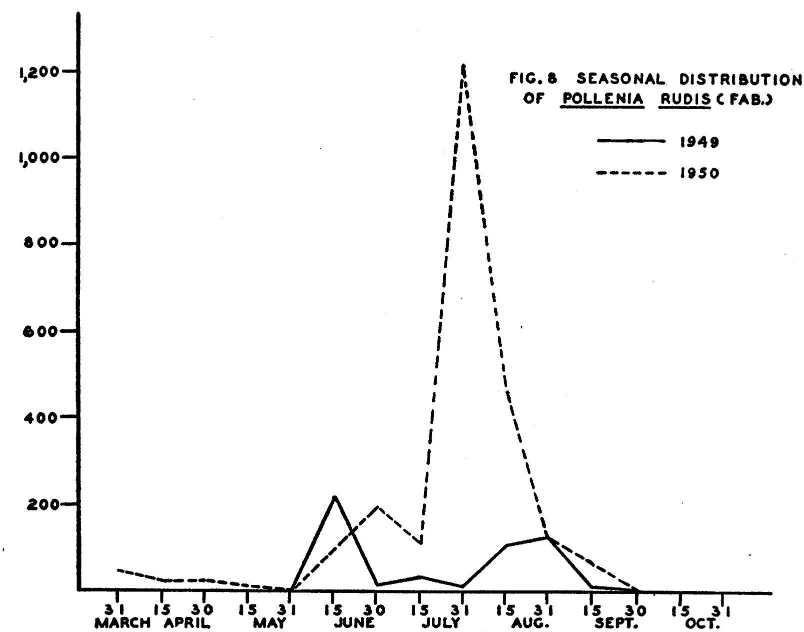


FIG. 8 SEASONAL DISTRIBUTION OF POLLENIA RUDIS (FAB.)

TABLE 2

SUMMARY OF TOTAL BLOWFLY TRAP COLLECTIONS TABULATED ACCORDING TO COLLECTION SITE

SPECIES	YEAR	COLLECTION SITE									
		Genetics Bldg.	Stock Pavilion	Hog Barn	Fur Farm	Sheep Barn	Pen Barn	Gugel Farm	Abattoir	Arboretum	Fish Hatchery
Phormia regina	1949	14,363	44,829	18,598	29,596	5,306	5,904	2,676	93,262	4,020	639
	1950	88,673	10,223	14,767	1,315	13,920	28,206	2,486	9,993	11,928	8,829
Lucilia illustris	1949	4,260	7,071	7,155	11,491	1,365	2,730	1,152	2,087	2,618	504
	1950	12,357	11,122	3,516	2,187	4,333	18,904	1,714	878	7,044	9,436
Phaenicia sericata	1949	3,988	11,380	14,351	6,580	8,172	3,558	7,821	15,523	228	102
	1950	2,562	6,096	10,546	377	3,882	2,522	1,970	1,388	196	360
Protophormia terrae-novae	1949	875	6,252	6,027	20,930	96	70	159	38,591	4	0
	1950	432	756	5,379	64	172	706	50	11,281	116	329
Bufolucilia silvarum	1949	634	1,007	885	3,427	28	176	53	769	326	365
	1950	1,152	1,185	376	447	211	3,143	301	585	542	3,306
Cynomyopsis cadaverina	1949	1,417	1,324	193	1,525	241	316	113	331	584	155
	1950	1,544	1,413	220	531	419	1,569	192	390	1,177	940
Calliphora vicina	1949	1,444	1,177	162	655	313	189	314	322	235	39
	1950	1,034	1,065	184	230	27	250	137	10	312	26
Pollenia rudis	1949	106	392	341	245	38	8	72	49	452	57
	1950	442	186	77	29	394	242	259	10	3,090	521
Phaenicia caeruleiviridis	1949	115	57	148	117	5	48	16	187	377	36
	1950	556	473	0	192	32	393	108	0	188	157

TABLE 2—(*Continued*)

SUMMARY OF TOTAL BLOWFLY TRAP COLLECTIONS TABULATED ACCORDING TO COLLECTION SITE

SPECIES	YEAR	COLLECTION SITE									
		Genetics Bldg.	Stock Pavilion	Hog Barn	Fur Farm	Sheep Barn	Pen Barn	Gugel Farm	Abat-toir	Arbore-tum	Fish Hatchery
Calliphora vomitoria..........	1949	370	414	89	500	30	16	7	166	73	61
	1950	262	324	80	206	142	230	18	13	168	26
Calliphora livida..............	1949	36	23	5	250	9	2	0	0	95	2
	1950	183	58	3	50	0	91	1	0	232	76
Callitroga macellaria........	1949	22	276	6	108	1	2	0	147	22	49
	1950	0	1	13	0	12	20	3	0	23	6
Calliphora terrae-novae........	1949	51	44	13	38	9	8	0	23	23	20
	1950	41	50	10	58	35	51	8	18	34	10
Eucalliphora lilaea...........	1950	2	1	0	1	0	1	2	0	2	2
TOTAL...................	1949	27,681	74,246	47,973	75,462	15,613	13,063	12,383	151,457	9,057	2,029
	1950	29,240	32,953	35,171	5,695	23,579	56,328	7,249	24,566	25,053	24,024

Total collections of species at individual collection sites are summarized in Table 2. Flies were most numerous in 1949 at a local abattoir (151,457) with 35.3 per cent of the total collection for that year. The second most abundant collecting sites were the Fur Farm (75,462) and Stock Pavilion (74,246) on the University campus. Flies were least abundant at the Fish Hatchery site (2,029). In 1950, collections at the Fur Farm (5,695) were only 7.6 per cent that of 1949 while at the abattoir (24,566) collections were 16.2 per cent and at the Stock Pavilion (32,953) 44.3 per cent. Collections were largest in 1950 at the Pen Barn (56,328) and least at the Fur Farm (5,695). Increased collections over 1949 were observed at the Pen Barn, Fish Hatchery, Arboretum, and Sheep Barn. *P. regina* was the most numerous species at nearly all of the collection sites. In 1949, *P. sericata* was most numerous at the Sheep Barn and Gugel Farm, and *L. illustris* was most abundant in 1950 at the Fish Hatchery. Fly populations for the two years were extremely variable throughout the collecting areas. For example, in 1949, 20,930 specimens of *P. terrae-novae* were collected at the Fur Farm while in 1950 only 64 appeared in the trap. At the Fish Hatchery, collections of *P. regina* were increased from 639 in 1949 to 8,829 in 1950. A similar increase for *L. illustris* also occurred at this collection site.

Summary: Collections of blowflies were made in the area of Madison, Wisconsin during 1949 and 1950. Bait traps were in continuous operation for a period of eight months at ten sites representing various conditions of blowfly breeding and attraction. Fourteen species of blowflies were collected. Listed in order of their relative abundance these were: *Phormia regina* (Meigen), *Lucilia illustris* (Meigen), *Phaenicia sericata* (Meigen), *Protophormia terrae-novae* (Robineau–Desvoidy), *Bufolucilia silvarum* (Meigen), *Cynomyopsis cadaverina* (Robineau–Desvoidy), *Calliphora vicina* Robineau–Desvoidy, *Pollenia rudis* (Fab.), *Phaenicia caeruleiviridis* (Macquart), *Calliphora vomitoria* (Linn.), *C. livida* Hall, *Callitroga macellaria* (Fab.), *Calliphora terrae-novae* Macquart, and *Eucalliphora lilaea* (Walker). The total blowfly catch for 1950 was only 61.4 per cent that of the total catch for 1949. A relatively cool spring and summer in 1950 combined with a much higher precipitation appeared to have an adverse effect on several of the more abundant species. While most species were adversely affected by the weather conditions of 1950, the catches for four species were increased over that of 1949. Fly populations were uniform for the two-year period at only one collecting site (Genetics Building). At all other sites, collections were extremely variable.

THE GREEK TRANSLATION OF AUGUSTUS' *RES GESTAE*

DONALD B. KING
Beloit College

Augustus liked to view the political institution with which he replaced the old Roman Republic as in fact a restoration of that Republic, and in writing his *Res Gestae* he stressed this republican view of the nature of his government. Everywhere in it he insisted on the forms and distinctions of the old Republic.[1] Further, he emphasized the fact that it was the Republic and people of Rome that profited by his deeds, and he failed to mention any service to the provinces of the Empire. In the words of one recent scholar: "Jamais oeuvre ne fut de destination plus romaine . . . qu'est-ce qu'un provincial y pouvait bien lire qui le touchât directment? Lorsqu'Auguste y parle des provinces, c'est seulment pour se vanter de les avoir conquises, pacifiées, ou recouvrées, c'est-à-dire, ajoutées ou rendues à l'empire du peuple romain."[2] The Roman emperor kept the distinction clearly defined between the Roman Republic on the one hand, and the empire, the possession of the Republic on the other, and he wished to appear only as the champion of the former.[3]

In the years after the death of the divine Augustus, however, a different concept and a different practice—the concept partly molding and partly molded by the practice, and the practice partly molding and partly molded by the concept—developed in the Roman world, finding its fullest expression in the teachings of the Stoic and Cynic philosophers, and its concrete manifestation in the persons and rule of the "good emperors" of the second century.[4] Many factors, of course, economic, political, religious, psychological, and physical, were involved in this change. Many of these factors were beyond the knowledge or power of the men

[1] J. Gagé, "Res Gestae Divi Augustae" (Paris, 1935), 35, says "Auguste ait cru devoir y soutenir avec tant d'application la version républicaine de sa révolution . . ." Cf. 24, note 1 of the same work, "Noter, dans ce sens, outre des formules traditionelles comme *l'imperium populi Romani,* le soin avec lequel Auguste . . . distingue, dans le ch. 15, les diverses categories du peuple de Rome . . ." See also W. Weber, "Princeps" (Berlin, 1936), I, 192–195, *et passim.*

[2] Gagé, *op. cit.,* 23–24.

[3] See Michael Grant, *The Augustan 'Constitution'* in "Greece and Rome" XVIII (October, 1949), 97–112, especially 102 *seq.* for discussion and some explanation of the importance attached to his championship of the Republic by Augustus and his contemporaries.

[4] See note 17.

involved, and so beyond their control, but in some small part, at least, the new concept and practice evolved as they did through the conscious effort of Roman officials. In the Greek translation of the *Res Gestae,* inscribed together with the Latin on the walls of the Augustan temple at Ancyra in Galatia, and probably in many other places throughout the eastern empire, there is evidence of the existence of such conscious effort, and some illustration of the manner and direction it took. For in the translation there is apparent, although hitherto not noted, an imperial attitude or point of view that is quite out of keeping with the republicanism of the original. The translator ignored or slurred over the Republican and Roman emphasis of Augustus, and stressed, on the contrary, the imperial aspects of his deeds. This attitude is apparent in the generalization of references to particular historical events and their results, and in the vocabulary and phraseology of the Greek.

The superscription of the Latin text reads as follows: "Rerum gestarum divi Augusti, quibus orbem terrarum imperio populi Romani subiecit, et impensarum quas in rem publicam populumque Romanum fecit, incisarum in duabus aheneis pilis, quae sunt Romae positae, exemplar subiectum."[5] The Greek reads simply: Μεθηρμηνευμέναι ὑπεγράφησαν πράξεις τε καὶ δωρεαὶ Σεβαστοῦ θεοῦ ἃς ἀπέλιπεν ἐπὶ Ῥώμης ἐνκεχαραγμένας χαλκαῖς στήλαις δυσίν. The two qualifying clauses in the Latin text, "by which he subjected the whole world to the empire of the Roman people" and, "which he expended on the people and Republic of Rome," bring out the fact that the deeds and expenditures of Augustus were to the advantage of the people and Republic of Rome. These two clauses are entirely omitted in the translation. The effect of this omission is twofold. The services described in the Latin as of value to Roman and the Romans are represented in the Greek as general services, and the distinction made in the Latin between a ruling Romen and the Romans are represented in the Greek as general Greek. Thus at the outset there is a clear example of the difference in spirit between the two copies.

In paragraph 1, Augustus begins the account of his deeds with mention of his action as a youth of nineteen in raising an army and forcing Antony to leave Rome (November 44 B.C.), thereby giving a measure of freedom to the Senate which had been dominated by Antony and his party since the assassination of Caesar. The Latin reads: ". . . exercitum privato consilio et privata impensa comparavi, per quem rem publicam a dominatione fac-

[5] All quotations from the *Res Gestae* follow the text of Gagé, *op. cit.*, and the references are to that text by paragraph and sentence.

tionis oppressam in libertatem vindicavi."[6] The second clause here is not translated very precisely in Greek. Instead we have the words, "Τὰ κοινὰ πράγματα ἐκ τῆς τῶν συνομοσαμένων δουλήας ἐλευθέρωσα." Τὰ κοινὰ πράγματα although it might pass as a translation of the Latin *"res publica"* has a much more generalized connotation than the Latin phrase. A more accurate translation would have been the phrase τὰ δημόσια πράγματα, which is used by the translator twice in other sentences of this same paragraph, or δημοκρατία, used by Appian and other Greek writers, both of which have the republican connotations of the Latin *res publica.*

Then the Greek words τῶν συνομοσαμένων are no translation of the Latin *factio*. The latter was used to denote a political clique,[7] and in this instance refers to the clique headed by Antony, the power of which was broken by Augustus. The ordinary Greek translation of this word was στάσις.[8] The words used here τῶν συνομοσαμένων, meant "the conspirators." They *were* used in Greek to refer to the party of the assassins who murdered Caesar. They are so used for example, by Cassius Dio in his discussion of these events.[9] This is probably their meaning here. Thus,

[6] See Weber, *op. cit.*, 140–142; Gagé, *op. cit.*, 73. In the next line of this same paragraph (*Res Gestae* 1, 2) Augustus says that *imperium* and other honors were granted to him by the Senate in return for this restoration of the Republic to liberty. It was Cicero in his fifth Philippic, delivered before the Senate on January 1, 43 B.C. (some days after Antony's departure), who proposed to that body that *imperium* be awarded to Augustus. In making the proposal (which was passed by the Senate immediately—see the Fasti of Augustus, Gagé, *op. cit.*, 163) he stated specifically that it was as a reward for Augustus' services against Antony in the previous two months that *imperium* was to be granted. *Philippics* V, 16, 42–45; "nullum erat consilium publicum, nulla libertas . . . hic (Augustus) ex Antonii amicia, sed amicioribus libertatis, contra Antonium confecit exercitum; . . . huius praesidio Antonii dominatus oppressus est. *Demus igitur imperium* Caesari . . ." Cf. *Philippics,* III 4–10; "qua peste (Antony) privato consilio rem publicam . . . Caesar liberavit . . ." Velleius, II, 60–61: "Torpebat oppressa dominatione Antoni civitas; . . . cum C. Caesar XVIIII annum ingressus . . . privato consilio maiorem senatu pro re publica animum habuit . . . mox cum Antonius occurrisset exercitui . . . eum (Augustus) senatus honoratum . . ."

[7] For the exact meaning of *factio,* see Lily Ross Taylor, "Party Politics in the Age of Caesar" (Berkley, Calif., 1949), 9 *seq.*

[8] For example: Appian, II, 146, ἐκ τῆς Πομπειου στάσεως. III, 4, ἐκ τῆς στάσεως; *et passim.*

[9] Dio, 46, 47, 3: ,'οἵ τε αὐτόχειρες τοῦ Καίσαρος γενόμενοι καὶ οἱ συνομόσαντες σφίσιν . . ." Cf. also Appian's phrase in reporting the words of one of the assassins who at the time of Caesar's murder exhorted the people to remember (*B.C.* II, 17, 119): "καὶ Βρούτου τοῦ πάλαι καὶ τῶν τότε σφίσιν ὀμωμοσμένων." Cf. further for the meaning of the word, Plutarch, *Sertorius,* 27, 4: "τῶν δὲ τῷ Περπεννᾳ συνομοσαμένων." It has been argued by Von Premerstein (*Abhandlungen Bayerischen Akademic,* No. 15 for 1937, pp. 26 *seq.*—"Wesden und Wesen des Principate") that the words τῶν συνομοσαμένων were meant by the translator to refer to the *factio* of Antony. Von Premerstein based this on passages in Appian (*B.C.* III, 46 and 58) and in Cassius Dio (XLV 13, 5) describing how many of the Roman senators joined with the army in taking the official oath of allegiance to Antony as head of the state in 44 B.C. This interpretation of τ συνομοσαμένων is not possible for two reasons: 1. The *factio* of Antony was the small group of politicians closely allied with him to control the state (see note 7 above) and not the great mass of thousands of Romans who owed and swore allegiance to him as an officer of the Roman Republic. Would we speak of Americans who had taken an oath of allegiance to the President of the United States as "conspirators"? 2. The senators who had taken this oath of allegiance were the very ones who were freed from the domination of Antony and his *factio,* as is clear

where Augustus wrote, "I brought freedom to the republic, which had been oppressed by the domination of a political clique" (meaning Antony and his followers), the translator wrote, "I freed society from the slavery of the conspirators" (meaning the assassins of Caesar and their followers).

Why? The answer, I think, is this. The action of the young Augustus in expelling Antony from Rome and the resultant freedom of the Senate and Republic of Rome from his control could be and were interpreted as services of value to Romans and to the Roman Republic. That appears clearly in the works of Cicero and Velleius, who speaks of it in almost the same words that Augustus used here.[10] On the other hand, even if known to the ordinary provincial of Asia Minor at the time of Augustus' death, this deed would not have appeared to him as a very great service. For some time before the battle of Philippi, however, Brutus and Cassius, leaders of the party of assassins, had overrun Asia Minor, besieged cities there, exacted large sums of money from the whole province. Accordingly the victory of Augustus over the conspirators in that battle might well appear to the provincials as liberation and a service worthy of record.[11] Thus the Latin copy notes a service of particular benefit to Rome and the Republic, whereas the Greek records instead a service to the empire.

In paragraph 25 Augustus wrote: "Mare pacavi a praedonibus. Eo bello servorum qui fugerant a dominis suis et arma contra rem publicam ceperant, triginta fere millia capta dominis ad supplicium sumendum tradidi." The Greek version of this reads: *Θάλασσαν πειρατευομένην ὑπὸ ἀποστατῶν δούλων εἰρήνευσα ἐξ ὧν τρεῖς που μυριάδας τοῖς δεσπόταις εἰς κόλασιν παρέδωκα.* The Latin sentences refer, as the editors point out, to the war carried on by Augustus against Sextus Pompey (39–36 B.C.), who had established himself in Sicily and was preying on Roman commerce with a force of escaped slaves and pirates. In the Latin copy Augustus brings out the fact that a particular war *(eo bello)* is referred to, and one which was fought against men who had taken up arms against the Roman Republic. "Er gibt diesem Krieg seinen eigenen Sinn . . . Die Befriedung des Meers von der Seeraüberplage, die Rettung Roms, Italiens, der *res publica* aus ihren Nöten, die Wahrung der Gesetze, der sozialen Ordnun-

from the second passage of Appian (B.C. III, 58) cited above. They were precisely the representatives of the constitutional Republic to whom Augustus restored independence from Antony. In other words they were not the *factio* but the victims of the *factio*.

[10] See citations in note 6 above.

[11] See Appian, IV, 8, 62; 8, 64; 9, 73; 9, 74; 10, 80–81. Laodicea, Tarsus, Rhodes, Xanthus and Peters were captured and forced to pay great sums of money. Besides this, ten years tribute was exacted from the whole province.

gen Roms, die Widerherstellung seiner Ruhe, sind notwendig, erweisen den Krieg als gerecht, den Sieger als den legitimen Hüter des *populus Romanus* . . ."[12] The Greek copy, however, by omitting all specific references to a war and to the Republic, records, instead of a victory which was specifically to the advantage of Rome and the Romans, only the general act which was of service to the whole empire, clearing the sea of pirates. Here again, then, as in the superscription and in paragraph 1, the Greek version neglects the Augustan emphasis on the fact that his deeds were services to the Republic and people of Rome, and records them instead as services of general imperial value.

The Greek translation of the Latin phrase *res publica* are further evidence of the difference in attitude between Augustus and the translator. This phrase occurs eight times in the Latin copy. It is only precisely and definitely translated into Greek three times. Two of these instances occur in paragraph 1 and have to do with Augustus' official appointment as dictator and triumvir, the third is in paragraph 7 and likewise deals with Augustus' triumvirate. In each of these three cases *res publica* is well translated by δημόσια πράγματα. In a fourth instance in paragraph 1, which deals with the action of Augustus in liberating the Republic from the domination of Antony, the phrase is translated by τὰ κοινὰ πράγματα. The generalizing significance of this translation has already been noted (p. 221). The fifth occurrence of the words is in paragraph 2, which refers to the war waged by the conspirators against the Republic. The Latin reads: "Et postea bellum inferentis rei publicae vici bis acie." The Greek reads: "καὶ μετὰ ταῦτα αὐτοὺς πόλεμον ἐπιφέροντας τῆι πατρίδι δὶς ἐνείκησα παρατάξει." The Greek substitutes the "fatherland" for the "republic" and thus, while not changing the facts of the case, changes the point of view. Augustus makes the point here, as he did in recording his war with Sextus Pompey, that the attack of his opponents was directed against the Roman Republic. He thus paints himself as her champion, her guardian against aggression, the picture of himself which would be important in the eyes of Romans. The Greek text, on the other hand, brings out the point that the conspirators were attacking not the Republic, but their fatherland and thus represents Augustus as the victorious opponent of traitors, a role which would enhance his prestige throughout the empire. In the superscription, in paragraph 25, referring to the war with Sextus Pompey, and in paragraph 34, the words *res publica* are omitted entirely. The omission in each case has the same effect, i.e., to represent an action of Augustus

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[12] Weber, *op. cit.*, 195.

as affecting the empire in general, instead of the Roman Republic alone.

Other evidence of the translator's general imperial point of view as contrasted with the strictly Roman attitude of Augustus is found in his treatment of the Latin words, *externas* and *universum*. In paragraph 3, Augustus wrote, "Externas gentes . . . conservare quam excidere malui." The translator generalized the clause by rendering it, "Τὰ ἔθνη . . . . ἔσωσα μᾶλλον ἢ ἐξέκοψα," omitting the word for foreign in Greek although he had just used it, ἐξωτικούς, a few lines above to describe wars which would have been foreign from the point of view of the empire as well as of Rome.

In paragraph 5, Augustus, discussing a food crisis in Rome, writes of freeing "*populum universum*" the whole people, from fear and danger by his administration of the grain supply. Of course Augustus' words are true of the *populum Romanum*, but from the viewpoint of the provincial, the use of *universum* here is nonsense, and the translator omits it. In paragraph 34 also, where Augustus writes of the mass personal oath of allegiance to himself sworn by the citizen population of Italy and the West, he uses the phrase "*per consensum universorum.*" Again "*universorum*" might be permissible exaggeration here if one were thinking only in terms of Romans, but would be very untrue as viewed by the provincial of Asia Minor. The translator renders the phrase "κατὰ τὰς εὐχὰς τῶν ἐμῶν πολειτῶν," leaving out any reference to "*universorum.*"

Other traces of this difference in attitude may be noted in the phraseology and vocabulary of the Greek translation. In his writing Augustus, "soucieux du mot précis et volontiers technique, surtout quand il s'agit du vocabulaire politique," was particularly careful to observe the political distinctions of the Roman Republic.[13] The translator was not so careful. In paragraph 1, Augustus emphasized that he had raised the army with which he freed the Republic *privato consilio et privata impensa*, i.e., as a private citizen without magisterial imperium. The translator ignored the words *privato . . . privata* and rendered the phrase simply ἐμῆι γνώμηι καὶ ἐμοῖς ἀναλώμασιν, although as appears in paragraph 21, he did know the Greek word ἰδιωτικός which would have translated *privatus*.[14]

Again, he translated *municipium*, which had a technical meaning in Latin, by the unqualified Greek word πόλις, instead of

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[13] Gagé, *op. cit.*, 38.

[14] Weber, *op. cit.*, 144, notes this change from the legal to the personal sphere. He says, "Das zweimalige 'privato'–'privata' überführt er aus der Rechtssphäre in die personliche (ἐμῷ–ἐμῇ)."

using the Greek μουνικίπιον, which was the technical equivalent of the Latin word,[15] and in so doing puts *municipia* on the same level as the other communities of the Empire. Also the three Latin terms, *populus (Romanus)*, *plebs (Romana)*, and *civitas (Romana)*, each of which has a distinct and different political meaning in the Latin copy are all consistently translated by the same Greek expression, ὁ δῆμος τῶν Ῥωμαίων, without qualification.[16] In this case, where Augustus distinguished between different divisions of the republic, the translator puts them all in the same category as "the state," the δῆμος. That he did this intentionally, and that his failure to distinguish between them was not due to the paucity of his vocabulary or to ignorance of the technical distinctions in the Latin words is shown by the fact that he did know a different and more exact Greek word for each of the Latin words. This appears in his use of ὄχλου to translate *plebs urbana* in paragraph 15 where he wishes to distinguish *plebs urbana* from the *plebs Romana* as a whole, and in his use of πόλις as a translation of *civitas* in paragraph 24, where it is not a question of the Roman *civitas*.

Again, to his translation of the phrase *corona civica* (par. 34) the translator added the qualifying phrase ὁ διδόμενος ἐπὶ σωτηρίᾳ τῶν πολειτῶν, in Greek to bring out the technical connotation of the Latin, where the connotation puts Augustus in a flattering light even from the imperial point of view. Also his use of ἔθνη instead of δῆμος to translate *populi* in paragraph 26, where it is a question of non-Roman and semi-civilized peoples, shows that he appreciated the technical connotations of words and could make distinctions in Greek when he wanted to do so. Thus, often where Augustus preserved republican forms and distinctions in his language the translator seems intentionally to have ignored them.

Further evidence of a similar nature is found in the translations of the Latin phrase *imperium populi Romani*, the empire of the Roman people. This phrase occurs six times in the Latin text. The first time it occurs in the superscription and is completely omitted in the Greek version as noted above (p. 220). The second occurrence of the words is in paragraph 13: ". . . cum per totum imperium populi Romani terra marique esset parta victoriis pax . . ." The Greek simplifies this as follows: "... εἰρηνευομένης τῆς ὑπὸ Ῥωμαίοις πάσης γῆς τε καὶ θαλάσσης ..." Note that the Greek again omits the phrase *imperium populi Romani*, sub-

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[15] *Res Gestae*, 3, 3; 16, 1; 16, 2; 21, 3. Cf. πόλις for *oppidum*—26, 5.
[16] *Populus*—*Res Gestae*, 5, 1; 14, 1; *passim*. *Plebs*—15, 1; 15, 4; App. 1. *Civitas*—5, 2.

stituting ὑπὸ Ῥωμαίοις, and also omits reference to the victories by which peace had been gained. The omission here as in the superscription has a double effect. The contrast between the ruling Roman Republic and the subject empire is considerably softened, and again a republican form preserved by Augustus has been ignored by the translator. The same effect is noted in other translations of this phrase in paragraphs 26, 27, 30 where *imperium* is translated in each case by the Greek word ἡγεμονία, a weak term for *imperium* and one which suggests the leadership of Rome, not the imperial possession of Rome. The Greek word κυριήα, which was in the translator's vocabulary (see par. 34) would have been a more accurate translation.

At this point it is possible to trace a pattern in the work of the translator. Where Augustus was careful to point up the value of his services to the Roman Republic, or where he preserved republican forms and precise distinctions in his language, the translator either changed, neglected or obscured the Augustan emphasis, giving a general and imperial application to what Augustus had given a parochial, Roman and republican stress. By these changes he produced a new and non-Augustan picture of the emperor and the empire. By his failure to translate the Latin phrase *res publica* and certain other phrases in the superscription and in paragraphs 1 and 25, the translator pictured Augustus as the benefactor of the whole empire, not of the Roman Republic alone. By his refusal to use the word *universum* of Romans alone, or the word *externas* of non-Roman peoples within the empire, or to translate the technical meaning of *municipium*, and by his translations of *imperium* as leadership, he represented the Empire as a group of communities and peoples without distinction under the leadership of Rome. This picture of a universal state of similar communities under Roman hegemony rather than a diverse group of Roman republican units on the one hand, and subject peoples on the other, is strengthened by his failure to convey in Greek the political distinctions involved in the Latin words *populus, plebs, civitas,* and *privatus*.

These divergences noted in the Greek are all the more remarkable in view of the high fidelity of the Greek to the Latin text in general throughout the document. Weber (*op. cit.* 224) concludes his comprehensive comparison of the two copies thus, "Oft genug wurde beobachtet, dass dieser Mann (the translator) mit seltener, fast peinlicher Treue dem Werk des Agustus, seinen Teilen wie dem Ganzen, sich hingegeben hat." Accordingly one must conclude that the examples cited are not the result of carelessness or negligence but show a definite intentional difference in the viewpoint of Augustus and the translator. Moreover, it is important to keep in mind when considering the question fully that for the ordinary Greek-speaking provincial the Greek copy of the *Res Gestae* was the only copy. The picture of Augustus and Augustan deeds in it is the one he would take away with him. Quite obviously, then, the translator wanted to convey to the provincials a different picture from the one Augustus had painted of himself. Augustus wanted to appear as the champion of the Roman Republic, to impress *Romans*. It was their good opinion he sought, not that of the provincials. The translator was evidently more concerned to impress the *provincials;* it was *their* good opinion he considered important.

This desire for the emotional loyalty and support of the non-Roman inhabitants of the Empire is significant of a change in the attitude of Roman rulers which was more and more to be reflected in their administration of imperial affairs. It is also significant of the actual political conditions that now prevailed in the Roman state. The Republic was dead. The technical distinctions of its political vocabulary could be ignored by the translator of the *Res Gestae* because they were practically speaking meaningless. The institutions for which they stood no longer had any real validity, and were being replaced by others. From the evidence of the Greek translation it appears that after Augustus' death Roman officialdom recognized the death of the Republic, in a way he had not, and considered it important to gain the allegiance and moral support of the whole empire, to weld its inhabitants together around the figure of the emperor as the benefactor of all alike. The Princeps was no longer to be the chief citizen and benefactor of a Roman Republic ruling a diverse group of foreign conquered states, as Augustus had pictured himself, but the chief citizen and benefactor of a universal state, as he is pictured by the translator.

The chief elements in this latter picture bring it close to the later Stoic–Cynic concept of the empire and the emperor.[17] For the philosophers, the Roman Empire is one universal state (*μία πόλις πᾶσα ἡ οἰκουμένη*); in this state there are no "foreigners"; and at its head is a leader (*ἡγεμών*) and benefactor (*ἐνεργέτης*) of all. Compare with these points the translator's refusal to use the word "foreigners" of inhabitants of the Empire (p. 224), his refusal to distinguish different classes of communities (p. 224), his designation of the Empire as a leadership (*ἡγεμονία*), and his

[17] For a good discussion of this concept see M. Rostovtzeff, "Social and Economic History of the Roman Empire" (Oxford, 1926), 127–128, and 115.

picture of Augustus as benefactor of the whole Empire (pp. 220–225). The existence of the Greek translation of the *Res Gestae* as a widespread and permanent document of propaganda must have made a material, if silent and unconscious, contribution to developing and fixing the *Stoic–Cynic* concept in the minds of the provincials in the eastern half of the Empire.[18]

[18] The identity of the translator, whether Roman or Greek, official or lay, has not been considered in this paper. On the basis of currently available evidence it is insoluble, and for the purposes of the argument here it is enough to note that whoever the translator was, his work was certainly inscribed on the walls of Augustus' temple with knowledge and approval of Roman officialdom.

PRELIMINARY SEDIMENTARY ANALYSIS OF THE PLEISTOCENE SEDIMENTS ON THE BOTTOM OF LAKE GENEVA, WISCONSIN

SYL LUDINGTON JR.

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No one is to be singled out for a major contribution as all had an integral part in the success of the experiment.

INTRODUCTION

The purpose of this analysis is to try to determine the age of the sediments on the bottom of Lake Geneva, Wisconsin and to correlate the results with known Pleistocene history following the Cary substage of the Wisconsin glaciation when the lake was formed.

The methods used were the mechanical analysis of sediments as outlined by Krumbein and Pettijohn (1938) and by the use of the Atterberg liquid limits machine to find the clay content in the sediments (Terzaghi and Peck, 1948).

It is known that there have been many changes in climate since the formation of Lake Geneva in Cary time, the largest being the Mankato substage about 25,000 years ago, Cochrane glaciation of 10,000 years ago, the climatic optimum 7,000 years ago, and the neoglacial stage ending about 100 years ago (Flint, 1948). Assuming that all the sediments at the bottom of the lake represent deposition since the Cary substage, it is hoped to correlate major breaks in the samples to these changes in climate.

Previous Geologic Work

N. M. Fenneman (1902) studied the shore features, the sources, and the outlet of Lake Geneva. He gives an exceptionally accurate account of the shore features, their formation, and the former height of the lake level.

W. C. Alden (1904) presents a detailed account of the glacial formation of Lake Geneva as a result of the Delevan lobe of the Lake Michigan glacier. It is a thorough presentation with accurate descriptions of the moraines, their position, and their lithology.

Alden (1918) further advanced his study of the geology of southeastern Wisconsin with certain revisions in the quaternary geology. He includes an analysis of the Ordovician and Silurian formations in the area.

W. H. Whitbeck (1921) studied the geography of the area for its temperature and rainfall characteristics.

Geography

Location

Lake Geneva is located between 88 degrees 15 minutes west longitude and 42 degrees 20 minutes north latitude in the southern part of Walworth County which is located in the southeastern section of Wisconsin. The lake is 8 miles long with a width ranging from ½ to 2 miles and trends east-west. At the west end of the lake is the city of Fontana with a population of 461 and on the north side Williams Bay is located with a population of 717. The largest city on the lake, Lake Geneva, is located at the eastern end of the lake with a population of 3,238 (1940 census).

Climate

The climate of the Lake Geneva area is near the southern boundary of the humid continental, short summer zone. This is more commonly known as the spring wheat area with an average growing season of from 3 to 5 months. The average annual range in temperature is 55 degrees (Finch and Trewartha, 1942).

The average yearly rainfall is 30 inches with rain or snow approximately 100 days a year. The lowest temperature recorded is 28 degrees below zero F. and the killing frost extends on the average from the middle of October to the last of April (Whitbeck, 1921).

Historical Sketch

The earliest recorded history of the area dates back to 1836 when the area was surveyed and the section lines were laid out by John Brink and John Hodgson who were government surveyors.

The name of the lake originated with the early settlers that traveled from Geneva, New York. The Indian name for the lake is Maunk Suck while the French called it Gros Pied after the Indian chief of the Pottawatamie tribe, Big Foot. The Pottawatamies lived at the head of the lake which is now known as Fontana but moved out of the area in 1840 after the government purchased their land. They were apparently a peaceful tribe as there is no evidence of any disputes with the whites (Baker, 1869).

Drainage

The water of the lake is derived from springs which discharge into the lake and from small streams which deliver the water from other springs in the area. There are a number of springs in Fontana area that deliver cold clear water by stream to the lake. At certain places, water issues from springs at the base of a bluff at a considerable elevation above the lake level. At the north side of Fontana and at the west side of the lowland north of William's Bay, the lines of seepage or springs lie 30 to 40 feet above the lake level. This results in the formation of peat on a slope below the seepage line that forms a terrace 10 to 20 feet high.

The outlet of the lake is in the northeast corner of the lake where the waters empty into the White River which flows in a northeasterly direction to where it joins the Fox River. Approximately 1 million gallons a day flow into the river, the water being controlled by a dam in the city of Lake Geneva (Fenneman, 1902).

LITHOLOGY

There are three formations underlying Lake Geneva that strike north and dip slightly to the southeast. The Ordovician Galena dolomite underlies the western section of the lake, and the contact is located at Yerkes Observatory on the north shore and old Marengo Beach on the south shore. Overlying the Galena dolomite is the Maquoketa shale (the Cincinnati shale of earlier reports with the base of the formation trending from Yerkes Observatory on the north and Marengo Beach on the south, eastward to Cisco Bay on the north to the Lake Geneva Yacht Club on the south shore. This is overlain by the Silurian Niagara dolomite with its western contact being the eastern contact on the Maquoketa shale, and extends as far east as Lake Michigan (Alden, 1918).

Galena Dolomite

This Ordovician formation is buff colored, uneven textured, earthy to finely crystalline, magnesian limestone, that is regularly bedded in layers about 4 to 14 inches thick. It is porous and in places showing small irregular cavities an inch or so in diameter. It carries an appreciable amount of chert in rounded nodules distributed along more or less definite horizons. The average thickness of the Galena dolomite combined with the older Trenton limestone is 260 feet (Alden, 1918).

Maquoketa Shale

The Ordovician Maquoketa shale is a soft bluish and greenish clay shale with intercalated magnesian limestone layers. This shale formation was easily removed where the capping of the Niagara dolomite no longer remains. The outcrops are patchy but the few that have been observed indicate that it lies conformably on the Galena dolomite. The average thickness of the Maquoketa shale is 185 feet but a driller on the south shore of the lake drilled 300 feet without passing entirely through it (Alden, 1918).

Niagara Dolomite

This Silurian formation lies unconformably on the Maquoketa shale and is associated with patches of Clinton iron ore. It is a white to bluish gray crystalline dolomite. It is generally well stratified in regular, little fractured courses varying in thickness from a few inches to 30 inches or more. The formation is generally rather fossiliferous and has an average thickness of 312 feet (Alden, 1918).

Glacial Geology

In the Tazewell substage of the Wisconsin glaciation the ice flowed westward down the preglacial Geneva Valley. This valley offered a discharge for the glacial waters which flowed southward through the north-south trending preglacial Troy Valley which was located to the west of Lake Geneva. When the ice advance ceased, Marengo Ridge was formed as a terminal moraine, it trends north-south and is located west of Fontana, Wis. This moraine blocked the outlet of the valley.

During the Cary substage, part of the Delevan lobe of the Lake Michigan glacier flowed southward across Geneva Valley and formed the Darien moraine located on the south side of the lake which covered Marengo Ridge and again blocked the outlet of the lake. The water then left the Nippersink outlet at Genoa Junction on the southeast side of the lake. The ice then retreated northward and formed the Elkorn moraine on the north side of the lake (Alden, 1904).

Coring Operation

The tube for the coring device was built out of steel tubing 8 feet long with an inside diameter of 1.510 inches. It was found that the inside diameter must be at least .010 inches larger than the 1½ inch plastic tubing that is inserted in the steel tube.

The weights for the corer were fashioned from two steel ball bearings with a combined weight of 110 pounds. The balls were welded opposite one another around a ten-inch length of steel tubing that had an inside diameter large enough to fit around the 8-foot tube but small enough so that a collar welded 2 feet from the top would prevent the weights from falling lower on the tube. A nose was made out of heavy gauge steel tubing that could be inserted in the lower end of the 8-foot tube. The nose was held in place by threading two opposite holes in the nose and inserting 2 bolts through the wall of the 8-foot tube into the threaded holes of the nose.

To retain the sediments in the plastic tubing small brass fingers were soldered to a brass ring that was placed between the nose and the plastic tubing which allowed the sample to pass into the corer but prevented the sediment from washing out. A valve was attached to the top of the corer that would allow water to pass through the tube on descent but would close on ascent to prevent water from washing the sample out of the plastic tubing (Figure 1).

A large steel barge was borrowed for the experiment that had a winch mounted in the center and a boom that could swing out over the front end of the barge. Three-strand ½-inch line was wound on the winch, passed through a block on the boom, and was attached to a hook on the top of the corer. The corer was allowed to fall through the water with the friction on the unwinding line on the winch keeping the corer in a vertical position.

It was difficult to tell the relation of core penetration to the length of the core obtained. Grease was rubbed on the outside of the corer in the hope that some idea of the penetration could be obtained but it was never known if the corer fell on its side after it penetrated the bottom.

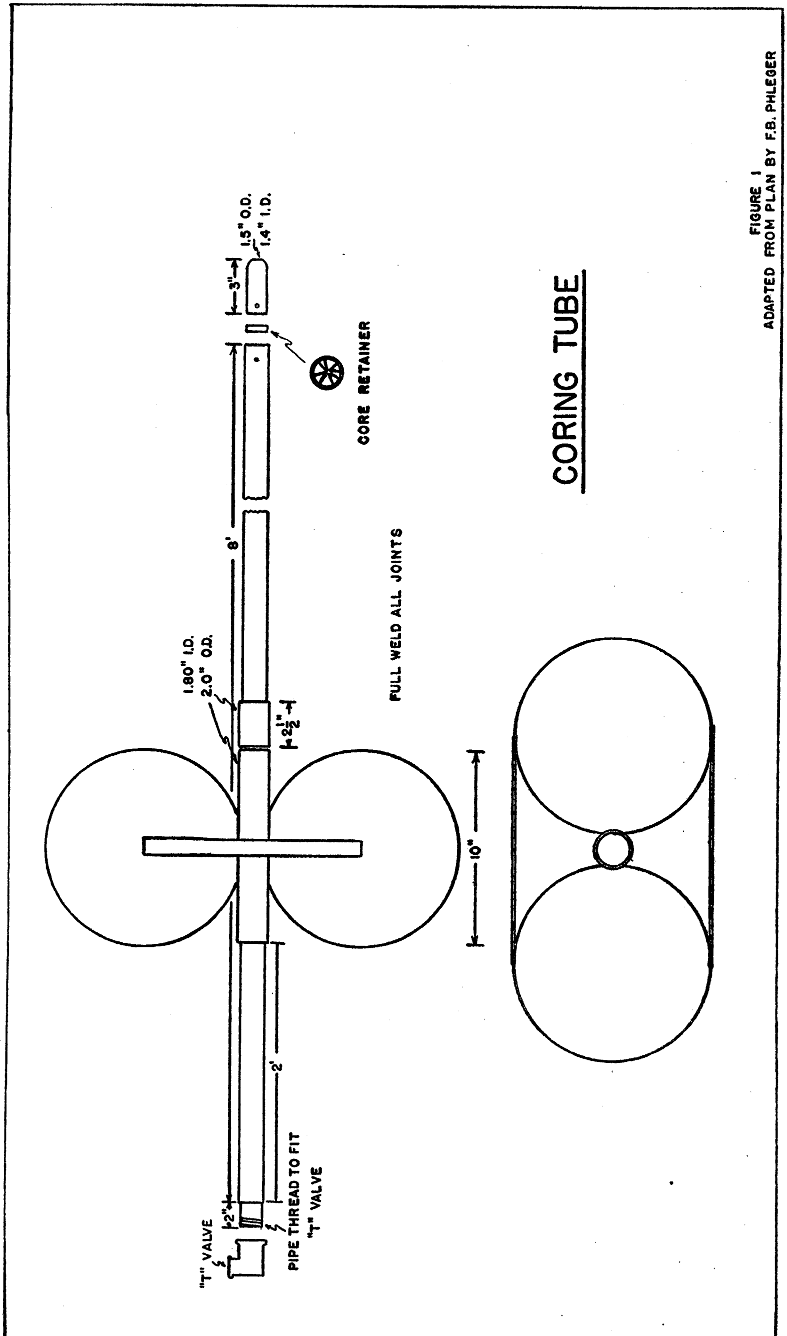

FIGURE 1
ADAPTED FROM PLAN BY F.B. PHLEGER

Analysis of the Cores

The cores taken ranged in length from 82 cm. to 46 cm., with an average length being 50 cm. The reason for the 82-cm. core is that the brass core retainer was not used and therefore there is not as much compression as in other cores. Of all the cores taken, core 4 with its 82-cm. length showed more than the other samples. It is recommended that if any further work is done on the Pleistocene sediments in the nearby lakes that the core retainer be omitted from the coring tube.

Each core was split in half lengthwise so that one half could be preserved for further analysis for pollen, organic material, and fossils.

The material in the cores when first opened was plastic, had a uniform texture, and had a dark gray color. When color changes were found in the cores, samples were taken above and below each change. Where no breaks were visible, the samples were taken at equal intervals in the core.

There were two methods of analysis used. The first was the pipette method outlined by Krumbein and Pettijohn (1938). The purpose of the pipette analysis is find the size distribution of the sediments. It also reveals the median size, the sorting, and the skewness. The second method which acted as a check on the first was the Atterberg liquid limits test described by Terzaghi and Peck (1948). The results of this test indicate the plasticity of the sediment which is a function of the per cent of clay minerals present to the rock flour and the kind of clay minerals present.

Results of Analysis

When the median size of the sediments at the top of each core is plotted on a graph the results indicate a pattern which parallels the depth of the water and the distance from the shore; the sediments close to the shore are coarse when compared to the sediments at the top of the cores taken in the center of the lake.

The sediments in the bottom of one core were coarse with traces of gravel which are of Cary age. Samples taken above this coarse gravel are fine and very plastic compared to the nonplastic gravels. This fine plastic sediment indicates that it was deposited after the retreat of the Cary glaciers. Above this fine sediment there is a change to coarse material, though not as coarse as the sediment in the bottom of the core containing the Cary gravel. This second appearance of coarse sediment should represent the effect on the lake by the Mankato glacier. This

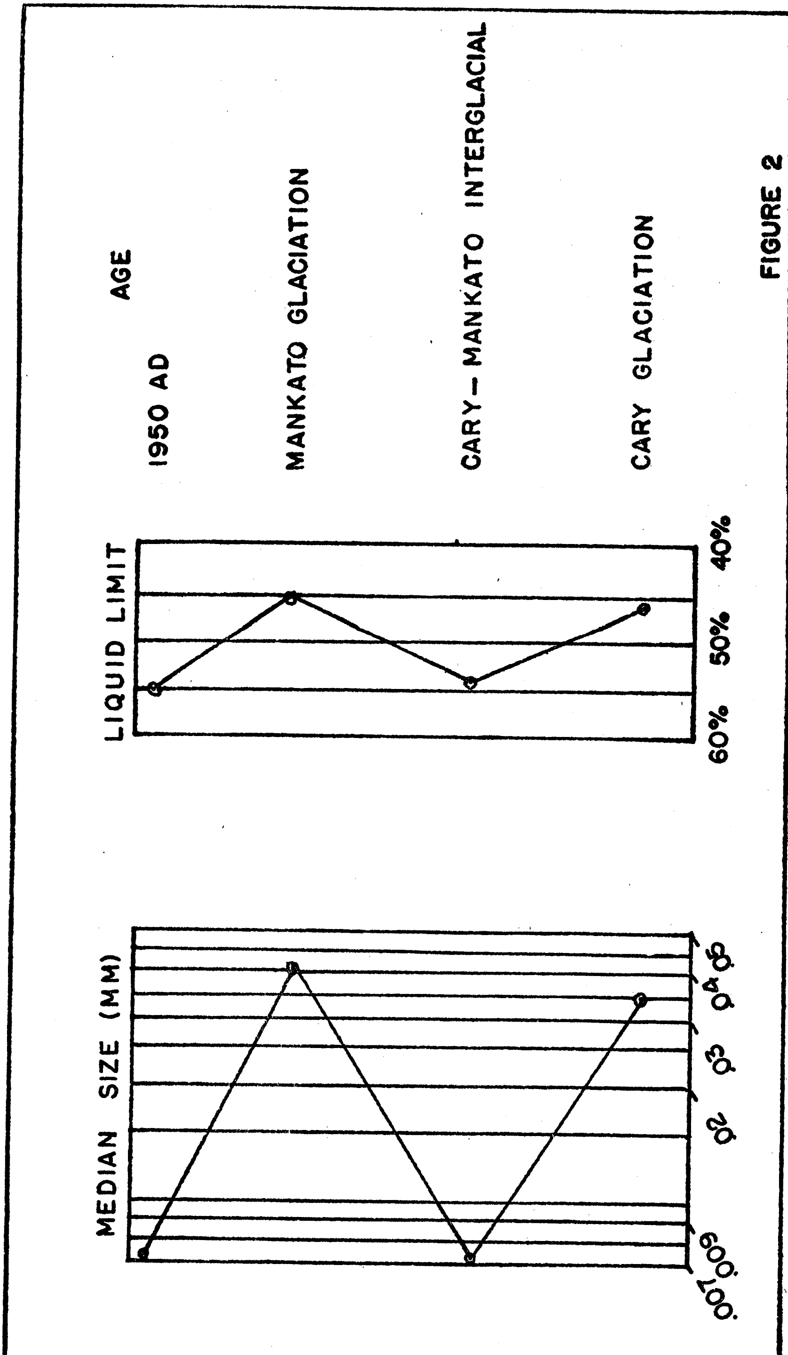
AGE
1950 AD
MANKATO GLACIATION
CARY – MANKATO INTERGLACIAL
CARY GLACIATION
LIQUID LIMIT
60%
50%
40%
MEDIAN SIZE (MM)
.0007
.006
.02
.03
.04
.05

FIGURE 2

coarse sediment has a low plasticity, and above this material there is a change to fine material with high plasticity, representing deposition of modern day sediments (Figure 2).

CONCLUSION

The Delevan lobe of the Lake Michigan glacier flowed southwestward until it reached the Illinois border near Walworth, Wisconsin. With the approach of the Cary–Mankato interglacial period, the glacier began its retreat and formed a recessional moraine on the south shore of what is now Lake Geneva. The glacier again retreated and formed a moraine which is now the north shore of the lake. As the glacier retreated to the north, the melt waters which were loaded with material emptied into the lake. With the warm interstadial period approaching, smaller size particles were deposited on top of the larger sized particles with their poorer sorting.

The Mankato glaciation followed the warm interstadial period and reached the south shore of Lake Winnebago which is 83 miles north of Lake Geneva. The glacier is supposed to have flowed south in the area which is now Lake Michigan as far as the Illinois–Wisconsin state line, if this line were projected across to Lake Michigan (Flint, 1948). The ice in the Lake Michigan area would have been 64 miles from the Lake Geneva area.

With Lake Geneva in the periglacial area there was increased frost action, precipitation, and loess was being deposited over the area by the winds blowing off the front of the glacier.

The increased waters in the streams emptying into the lake increased their load that resulted in larger size particles being carried into the lake.

With the retreat of the Mankato glacier, precipitation decreased, chemical weathering increased, and the particles again became smaller with better sorting. This condition continued until the present day with good sorting and a small median size in the sediments.

Though there have been changes in climate since the Mankato, they have not been large enough to cause an alteration in the size of the sediments on the lake floor.

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